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ENGINEERING & MINING JOURNAL-PRESS

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Mackay Electrochemical Process for Copper Ores

By Henry S. Mackay

All metallurgists will be interested in the details of this method proposed for treating the Mount Elliott ores in Australia

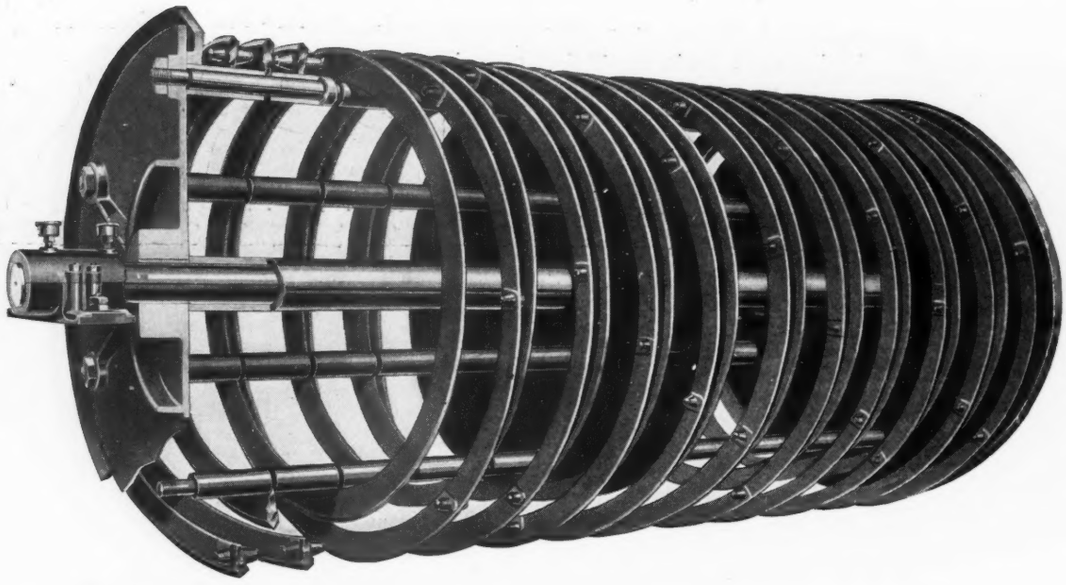
The Chino Enterprise—III

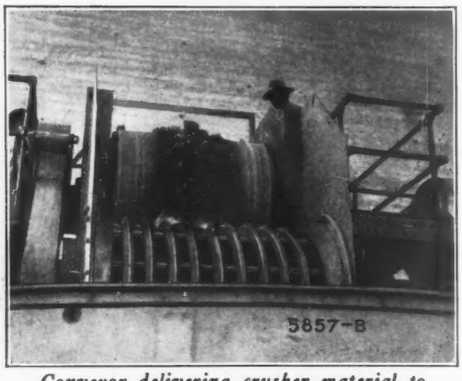
By T. A. Rickard

Silver Fifty Years Ago and Today

By H. R. Van Wagenen

Views of the Mexican Corporation Operations at Fresnillo, Zacatecas





Conveyor delivering crusher material to Burch Grizzly.

Looking down past Burch Grizzly into crusher

An "Ace" for the "Queen"

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The Burch Grizzly is absolutely non-clogging, the ingenious arrangement of fixed and loose rings provides accurate spacing at the top while giving complete freedom of release for the fines.

Built in three standard diameters: 36, 48 and 60 inches, and in any width up to ten feet. The ring spacing can be adjusted for specific requirements.

STEPHENS-ADAMSON MFG. CO.
Aurora, Illinois

BURCH *Grizzly*

ENGINEERING & MINING
JOURNAL-PRESS
JOSIAH EDWARD SPURR, Editor

Volume 116 New York, December 8, 1923 *Number* 23

Vicissitudes of the Gold Seeker

THE ROMANTIC SIDE of gold mining seldom is heard of in these prosaic days, and many were the appreciative and interesting comments of those who learned that an adventurous spirit had gathered together a following of 107 persons in San Diego and Los Angeles last spring, with whom he set out from San Francisco in a sailing schooner for Alaska and anticipated fortune. All went well until their destination was sighted, fine weather having added to the zest of the expedition. The ship finally anchored off Port Clarence Bay, less than two miles from shore, and preparations were made to deliver the freight, human and otherwise, ashore. Unfortunately, a gale sprung up, the anchors dragged and in a short space of time the "Fred. B. Wood" was a wreck. No lives were lost, but the gold seekers were deprived by the accident of all their worldly possessions, suffering considerable privations because of their misfortune.

However much we may admire the pluck of such adventurous spirits, one might well deride their foolhardiness. The organizer of the expedition, according to newspaper accounts, was tried in Seattle in 1911, charged with fraudulently seeking to obtain money for a former expedition. The jury disagreed, and the case was dismissed. Whether the method of raising funds for financing subsequent efforts in the same direction was open to similar criticism we cannot tell; but the sad event on the coast of Alaska should prove a warning to others who are inclined to let romance and the possibility of easy money interfere with common-sense conclusions. Prospecting needs adequate financial backing and efficient management. All the chances were against the success of the expedition, even though the fates had been kinder toward the sailing vessel that bore its burden of humanity and hope to Alaska.

However, in spite of all warnings, indirect and direct, a section of the population is always willing to take a chance of becoming affluent by participating in a game of which they have no inside knowledge. California newspapers state that, nothing daunted, the directors of the company plan to buy another vessel early in the spring of 1924 and repeat the experiment. Participants in this game of uncertainty will doubtless be harvested in Los Angeles, the one city in the United States toward which a steady stream of individuals with a small cash reserve is pouring. Recently, in less than one month, the Santa Fe Railroad company made 3,300 refunds to persons who had booked round-trip tickets there from various parts of the United States, but who had fallen under the lure of what has been termed the Wonder City of America and decided to remain. Among the less solid attractions of Los Angeles are an almost infinite variety of get-rich-quick schemes, of which mining has of late been conspicuous. The influx of budding capitalists to the western metropolis is such that Los Angeles ranks high as a financial center for the promotion of those types of speculative offerings that attract the individual with a modest wad of hard-earned savings.

The ardor of the enthusiasts who took part in the 1923 prospecting expedition to Alaska was considerably dampened, according to reports, many of them having to sell some of their clothes in Nome to insure continued association of body and soul until work was secured in some local industry. It would seem that, if any funds are available, the company might well have taken steps to relieve the distress caused by the last disaster. There appears to be plenty of money available in the West for promotions of this character. A recent issue of a reputable San Francisco daily prints a letter of thanks to the proprietors in appreciation of the results obtained by an appeal for funds to finance a mining undertaking in Mexico, the prospectus of which showed available wealth in unheard-of amounts and promised dividends that to ordinary investors would seem to be beyond the dreams of avarice. It is realized that a certain type of investor must learn his lesson by bitter experience, but the directors of legitimate mining enterprises will regret that so much good money goes to waste before he is convinced of his misplaced confidence.

A Suggestion as to Taxes

SENATOR PAUL DUPUY, of Paris, France, has a bright idea, so bright that it is bound to tarnish even before he sails back to Paris, from which he recently arrived. For humanity's woes the Senator has a panacea—a panacea of taxation. The evils of taxation he would cure by more taxation—taxation of the mining industries on an international scale. If he is quoted correctly by the press representative who recently interviewed him, his proposal, should it prove acceptable to the governments of the world, would make the income tax unnecessary and reduce the taxation of all nations to less than half of what it was before the World War. "Everyone knows where the mines are," the Senator is quoted as saying. "They cannot be hidden. And the tax, imposed at the source itself, would be paid without the grumble that accompanies the payment of the income and other taxes. . . The tonnage tax on iron and other natural resources which God has given us, could be fixed proportionately. The tax, of course, would be paid by the ultimate consumer, but it would be the indirect form of taxation, which causes little or no grumbling."

The flaws in this beautiful scheme, which would tax the mine owner and let others go free, are too patent to be worth discussion. It might be asked in passing, though, where would our revenue have been in the recent period of depression in the metal-mining industries if the government had depended on a tonnage tax, light or heavy, to meet its expenses?

It is said that the Latin mind normally proceeds

from the abstract to the concrete. This theory of Senator Dupuy is hopelessly sunk in the abstract, and it is easy to predict difficulties when he attempts to get down to brass tacks and show the world how it can be done.

Herculaneum Will Not Close Down

GREAT AMALGAMATIONS or business reorganizations generally cause numerous changes in plant operation and personnel, and much interest is usually taken in the district affected as to what these changes may be. In the St. Joe-Federal Lead agreement, for example, many opinions have been expressed by various interested observers as to the probable ultimate fate of the Herculaneum smelter of the St. Joseph company, now that the largest part of the concentrates produced in Southeastern Missouri is to be smelted at Federal. It was thought in some quarters that it would not be profitable to operate the Herculaneum smelter on a small tonnage. This opinion was reported in an editorial published in our Nov. 17 issue, at which time the hope was expressed that a way would be found to continue the operations there, inasmuch as the plant was a modern one and many people were dependent on its continued operation. We take great pleasure now in reporting a statement recently made to us by Clinton H. Crane, president of the St. Joseph Lead Co., who said that the Herculaneum smelter would continue to operate so long as that company has anything to say about it. This will be welcome news to the community at Herculaneum. The decision to keep the plant running is no doubt due to a desire to have ample smelting facilities in reserve in event of any interruption at Federal.

When Ore Solutions Are Blocked

IN OUR ISSUE of Nov. 17, Mr. Henry H. Knox, our temporarily (we hope) Transatlantic contemporary, points out what he considers a fundamental error which runs through all geological literature: namely, the fallacy (as he believes) of attributing the known phenomenon of the "making" of ore, where a fissure intersects an impervious or difficultly pervious rock, to a damming of the upward-flowing (let us instance) ore solutions. He argues that in the difficultly fissurable rock the fissure channels will be smaller and narrower than normal; hence that the flow of ore solutions along the fissure, from below (let us say) to above this less frangible rock, will be accelerated, rather than impeded or dammed, since the volume of solution passing through a given fissure must be constant at all points, whatever the width. Hence he suggests the term "constriction" as more accurate than "damming" and the like, since the latter group of terms represent the opposite of what he conceives to be the case—they indicate a slowing down of velocity, whereas he argues an increase.

Given Mr. Knox's premises, his conclusions are logical. The natural occurrences on which we must base our conclusions, however, indicate that we must make other premises than those with which Mr. Knox starts. We must start with the fact that, in very many cases, when a fissure on its upward course encounters a relatively tough and non-frangible rock—such as a bed of shale or a sheet of decomposed porphyry, then the ore which characterizes the fissure spreads out, often far and wide, beneath this non-frangible bed. Sometimes, also, the ore in part penetrates through the bed, along the main fissure, and ascends till it encounters another unyielding bed, under which it spreads out again, and so on: for example, at Leadville, as shown in Spurr's "Ore Magmas," Vol. I, Fig. 68, p. 353.

Now, since the deposition of ore marks the path of the ore solutions, it is evident that the ore solutions or ore magmas, as we choose to call them, ascending along the fissure, have been deflected to an important degree by the difficultly frangible and difficultly permeable shale or porphyry. Being deflected, it follows that the shale or porphyry acted as a barrier—more or less effective; that is to say, a dam. That the solutions were held back, deflected, and therefore "dammed," appears therefore to be certain. Mr. Knox pictures this damming like the damming which impounds tailings in a tailing pond and believes that the action cannot be like this. But in the case of rock-magma intrusions, which are likewise deflected by shale and decomposed porphyry beds, and spread out far and wide, exactly as ore magmas do, there is a certain impounding of the rock magma behind the likewise deflecting dam, and this magma when crystallized, results in thick sills of igneous rock (porphyry, let us say), which are often "fed" by relatively inconspicuous dikes.

It is probable that the mode of injection in many ore magmas is not very dissimilar from that of rock magmas. The assumption of ore deposition gradually from waters moving in vast quantity through a channel and gradually building up a vein by deposition on its walls is one that requires demonstration, and in most actual occurrences cannot be demonstrated, although it is an ancient hypothesis. But in any event the action of the dam is to deflect the current of ore magma as well as to impound it. But that it does impound it in some degree is shown, in nature, by the excessive deposition of ores at the junction of fissure and partly damming rock. This excessive deposition spreads out and occupies far more space than does the ore in the feeding fissure, showing that the ore magmas spread out from the feeding body, when backed up by the overlying barrier, into a much larger space than below.

Aluminum for Copper

THE LETTER in the Discussion pages in this issue, from the Aluminium Français, which company holds the same overwhelmingly preponderant position in the aluminum industry of France that the Aluminum Company of America does in the United States, is of great interest. Correcting a report published in our French correspondence, this company advises that it has just sold two thousand tons of aluminum wire to be used by the Southern Railways (Chemins de Fer du Midi) of France in their electrical equipment instead of copper. Two thousand metric tons is nearly four and a half million pounds; and this represents approximately that amount of copper which the Copper Export Association or the independent marketers will not be able to sell in France. Of course, the governing motive is economy. It is difficult for France, with her depreciated franc, to buy copper from us even at the present low price; but she manufactures her own aluminum, saves money by using it for electrical equipment, and the country conserves its scanty gold reserves. Doubtless government fiscal policy had something to do with this choice.

This illustrates a process of substitution which will take place as and when and where any metal or mineral product becomes difficult to obtain, whether on account of its scarcity in nature and the consequent rise in

price, or, as in the case of France, because of a depreciated currency and a low stock of gold. A long series of such substitutions can be foreseen. It is necessary for miners to study intensively their marketing problems, which involves a most general and intelligent study of economic and industrial trends.

The Prince of the Mining Frauds

THE PRINCE of all the wildcats, promoted by the king of all the liars, would seem to be the Sitka Gold Mining Co., alias, it seems, the Pacific Gold Mines Co.

The Sitka Gold Mining Co., according to an attractive and plausible prospectus, is incorporated under the laws of Nevada and capitalized at 10,000,000 shares at a par of $1 each. H. G. Torrence is president. The properties have been examined and reported on by seven M. E.'s, whose names are given. The company offered 500,000 shares of the treasury stock at $1 per share. The Sitka River Mining Co. owns, the circular states, the Cooper River Placers at Seward, Alaska; the Susie Gold Quartz group at Sitka, Alaska, and the Mineral Hill group, in Eldorado, Calif. The president says these are three of the largest proven gold mines in the world. He says that the Cooper River Gold Placers have proved up one-third of the acreage, showing "pay gravel totaling approximately 100,000,000 cubic yards, that will average over fifty cents a yard net, or a total of approximately $50,000,000 in gold." In round numbers! The remaining two-thirds, not yet proven, indicates higher values! See the reports, says the president, of J. M. Jackson, E. M.; Wm. Blankenship, M. E., and W. J. Bender, M. E. The Susie Gold Quartz Mine, on Baranof Island, near Sitka, has an exposed quartz ledge 700 ft. high, 200 ft. wide, and 4,800 ft. long. "Ore reserves, blocked out on the surface, exceed 37,000,000 tons, assaying according to one engineer, $10.60, and $11.08 according to another."

The Mineral Hill group, in Eldorado County, Calif., contains, according to reports of Burr Evans, M. E., and H. J. Powers, M. E., over 500,000,000 tons of ore averaging 3 per cent copper, all of which can be gravity mined. Besides the copper, there is an average of $9.42 in gold and 6 to 14 oz. silver!

Neither the president nor any of the officers want a cent of salary until dividends are paid. The president, as he himself admits, was formerly the mining partner of Cecil Rhodes.

We are informed by the editors of "The Mines Handbook," that in their endeavor to find about the phenomenal mines described in the circular, they appealed to the U. S. Geological Survey. The Geological Survey had no record of the Sitka Gold Mining Co. of North America, or the Cooper River Hydraulic Gold Mine of Alaska. The Survey opines that there is no Cooper River in Alaska. Next "The Mines Handbook" editors appealed to Mr. B. D. Stewart, Territorial Mine Inspector, at Juneau, Alaska. Mr. Stewart wrote: "I have investigated these two companies in the office of the Secretary of the Territory with whom all corporations must register in order to legally do business in the Territory. I find that neither of the companies concerning which you made inquiry have ever been of record in the office of the Secretary." Finally inquiry was made of the Secretary of State at Carson City, Nev., Mr. George Brodigan, who writes: "In reply to the above we beg to advise that we find no record of any such corporation as the Cooper River Syndicate." And there you are! One hundred million proven yards of fifty cent gravel, which cannot be found! Thirty-seven million tons of exposed eleven dollar gold-quartz which has slipped into a crevice and got lost! Phantom mines that the Secretary of Alaska cannot see; and a phantom corporation of which the Secretary of the State of Nevada has no perception!

Later, apparently, than the above circular is that of the Pacific Gold Mines Co. of North America, which appears to be a new holding company, supplanting the Sitka Gold Mining Co. The Pacific Gold Mines Co. of North America does not claim to be specifically incorporated anywhere; but it owns the same three record-breaking group of mines mentioned above, examined and reported on by the same redoubtable battery of seven M. E.'s, and has the same H. G. Torrence, of Oakland, Calif., as president. Also, the company is capitalized at $10,000,000 and is offering 500,000 shares of treasury stock at $1 per share. In fact, it is the same circular as that of the Sitka Gold Mining Co. In a letter from the president to one Bernard Sandler, of 261 Broadway, New York, dated June 1, 1922, he reiterates the tonnages and values of the different properties above mentioned. Attached to this circular is a "Who's Who" of Mr. Torrence, and his mining career from 1882 on. In 1897 he went to the Yukon, and from "Nugget Bar" and other placers which he operated for himself and Cecil Rhodes, produced $23,000,000 in gold. He modestly makes it only $16,000,000, but he overlooked the $7,000,000 odd which he produced from "Nugget Bar"—in whatever land of delusion "Nugget Bar" may lie. Finally, we are told of Mr. Torrence: "He is sincere, capable, experienced, honest, conservative, and is committed to the success of the Pacific Gold Mines Co." Kind words from Mr. Torrence to himself!

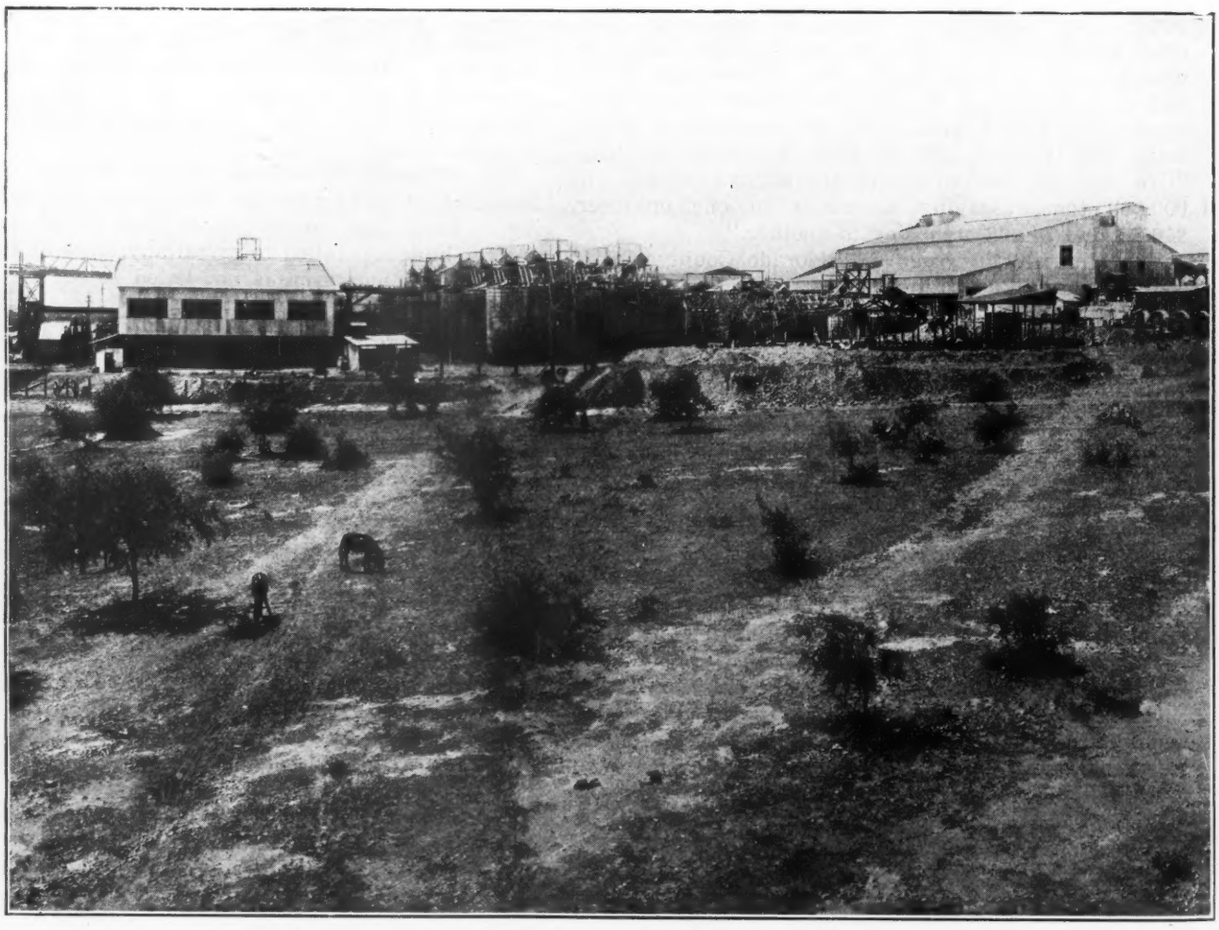
The offices of the company are at 25 West 43d St., New York, Cooper River in Alaska, and Federal Building, in Reno, Nev. A visit to 25 West 43d St., which is a great building, failed to reveal any trace of the company, which, moreover, is not listed in the New York telephone directory. As for Cooper River, the Geological Survey says there is no such river.

Still, the fact remains that stock salesmen are now selling this stock, as appears from reports here and there—selling stock in "Three of the largest proven gold mines in the world." Let us hope that the law will put a stop to their depredations.

Ford a Lead Producer?

THE REPORT that Henry Ford was looking for properties in the Southeast Missouri lead belt, which would make him independent so far as the supply of lead for flivvers goes, is no myth. Drilling equipment with his name on it is actually going into the district. The probability that he will find a deposit of sufficient size to work is, however, not great. There are undoubtedly undiscovered ore deposits, but most of them are probably of an extent better adapted to development by existing companies. A large amount of drilling has been done in the last few years throughout the district and everything of promise has been picked up. One of the new producers, the Annapolis Lead Co., situated in an outlying district, is reported to be in a precarious condition, with developed ore hardly sufficient for its new mill. A newcomer in this district will require vast resources, which of course Ford has, and even then very likely will not make a success of it.

Panorama showing Proaño Hill, Zacatecas, Mexico,



The 3,500 ton cyanide plant of The Mexican Corporation

e plant of The Mexican Corporation, near Fresnillo

Views of The Mexican Corporation's operations at Fresnillo, Mexico

The surface on Proaño Hill, showing the glory holes (see the front cover)

Silver Ore Today and 50 Years Ago

Can We Win a Profit From What the "Old-Timers" Left—Interesting Comparisons

By H. R. Van Wagenen
Mining Engineer, Los Angeles, Calif.

IT IS A HALF CENTURY since silver was demonetized. The price today closely approximates a half of $1.29, the price that prevailed then. Assume a 20-oz. silver ore, carrying negligible gold content. If the "Old-Timers" left it because it was too low grade, can we mine it today, and why? The answer would be at hand had we more complete data on their costs. Much has been lost and destroyed, but thanks to such able observers as Rossiter Raymond we have some records.

A dollar today buys far less labor than it did fifty years ago. Then a miner received $3 to $4 per shift; now, $5 to $7.50; that is, it takes about two dollars today to purchase the labor that was bought for one dollar of 1873; assuming equality of effort and ability.

Upon the above quotations and premises, an ounce of silver was four times as valuable fifty years ago as it is now; and the 20-oz. ore appears to have been worth as much to the "Old-Timers" as an 80-oz. product would be to us today. But, of course, that is absurd. The science of and the equipment for mining and milling have progressed tremendously since then. How far-reaching has been this gain in efficiency in determining the comparative value of the 20-oz. ore?

In 1873, mining was largely a matter of double-jack hand work; a drill twister and two hammer men. Their pay was, we will say, $3 per day—$9 for the crew. Another dollar would probably cover the steel sharpening and nipping; total $10. The accomplishment, in hard siliceous rock, was about 15 ft. of hole. The cost per foot was, therefore, about 67c.; that is, 67/100 of the 1873 dollar.

At present, a $6 miner, with a modern one-man machine, will drill a round of nine or ten 5-ft. holes in the face of a drift in three hours of drilling; and, in a stope, put in ten to fifteen holes, 7 or 8 ft. deep, or the equivalent. The cost of compressed air, steel sharpening, and nipping, lubrication, machine upkeep, hose deterioration, pipe extension, and such incidentals will hardly be less than about $4 for the shift, depending largely on the cost of power. On these figures, a foot of drilling in the stope costs today somewhere around 10c.; that is, 10/100 of the 1923 dollar. Comparing this with the 1873 performance the ratio is 6 or 7 to 1, in favor of the present, in terms of dollars; and 3 or 3½ to 1 in terms of ounces of silver in an ore. As far as drilling is concerned, then, the 20-oz. ore is as good for us as a 60- or 70-oz. product was for the miner of a half century ago.

The element of rock breakage must next be considered. Until about 1870, black powder was the only explosive available; then came "giant powder," a dynamite much inferior to our modern explosives.

Early-day stopes and drifts display enough remnants of drill holes to justify the conclusion that fully twice the number were required to break a 5 by 7-ft. heading as now. In other words, much less ground was assigned to a hole charged with "giant powder" than is allotted now to one loaded with dynamite. Even in the stopes, at places where the chance to break was fine, remnants show clearly that very many more holes were drilled than would be today. And the old holes were short, seldom exceeding 3½ ft., even in large and open stopes. With present-day practice of 6- to 8-ft. holes in moderately wide stopes, and up to 20 ft. in large chambers, the discrepancy between tons-per-foot-of-drill-hole, then and now, must be great, very great indeed; as much perhaps as 4 or 5 to 1, on the average of a stope's life—its start, maturity, and finish. Using the lower ratio, 4 to 1, and applying the 6 to 1 ratio (dollars) for the cost of drilling, it would seem that breaking in the stope today is only $\frac{1}{24}$th as costly as in the olden days.

Now as to the cost of explosives. A 3½-ft. hole, 2 in. in diameter, with 6 in. of tamping, will hold between 5 and 6 lb. of powder. In the 70's, the price of black powder was $5 to $6 per keg of 25 lb. at San Francisco, and giant, according to Raymond, was worth $1 a pound at Pioche in '72. To transport supplies from San Francisco to Virginia City, Austin, Eureka, Hamilton, Tuscarora, or Pioche cost from $20 per ton to the first-named camp to $100, or more, to the last named. However, putting the price of black powder at the mine at only $6 per keg (24c. per pound), the cost of the explosive per foot of drill hole would have been approximately 38c. Today, our stope holes, averaging, say 8 ft. in length and 1¼ in. in diameter, are loaded for 50 to 60 per cent of their length with dynamite, costing 16 to 20c. per pound. This works out to about 9c. per ft. of drill hole, a ratio of about 4 to 1, as compared with the early-day cost.

To apply these factors, a figure for present costs must be assumed. Explosives, per ton of ore broken, are not high at 10c. Drilling, including air, blacksmithing, nipping, and machine upkeep, seldom is lower than 50c. per ton. Using these, we have the following comparison:

	Per Ton		
Cost of breaking—1923	$0.60	= 4.6	per cent of the gross value of the
Made up of drilling..$0.50			20-oz. ore, at the 1923 quotation
and explosives..... 0.10			(20x$0.645 = $12.90)
Cost of breaking—1873	13.60	= 52.7	per cent of the gross value of the
Made up of drilling..12.00[1]			20-oz. ore at the 1873 quotation
and explosives..... 1.60[2]			(20x$1.29 = $25.80)

[1] 6 to 1 times 4 to 1 = 24 to 1. 24 x $0.50 = $12.00
[2] 4 to 1 times 4 to 1 = 16 to 1. 16 x 0.10 = 1.60

To express these results in tenths of 1 per cent is, of course, a refinement entirely disproportionate to the broad assumption underlying it—namely, that the tons broken per foot of drill hole are today four times as many as in the olden times. I know of no way of further scrutinizing that point; it is a matter of judgment, in which there is much room for argument. However, I believe more engineers and miners would regard a ratio of 5 to 1 to be nearer the truth than would advocate the proportion of 3 to 1. At any rate, progress in the art of breaking ground has been great.

Has it been as good in all the other steps in the process of converting ore-in-place to bullion-at-the-mint? Has not our advance in the science of economic geology during the last five decades put within our reach reasonable expectations for discovery that formerly were unsuspected? These are subjects for further consideration, but from the foregoing it is evident that, in consequence of our present higher standards of mechanical and metallurgical practice, added to our broader and more detailed knowledge of geology, the ore deposits worked early in the history of the West, and since abandoned, must be given very careful study before reaching the conclusion that they are of no value, even when silver is quoted at half its former price, and when the modern dollar has vastly inferior purchasing power to its brother of a half century ago.

The Mackay Electrochemical Process for Copper Ores

Sulphide or Oxidized Material First Roasted in Furnaces Adapted for Close Temperature and Gas Control, Making Iron and Other Impurities Largely Insoluble—Copper Then Leached and Electrolytically Deposited

By Henry S. Mackay
Mining Engineer, London

Henry S. Mackay

TO SHOW the difference between this process and similar processes it is necessary to give a brief history of hydrometallurgical and electrochemical methods. All processes where part of the metal is precipitated by electrolysis and part of the solvent regenerated will be classified as hydrometallurgical, and those in which all the metal is precipitated by electrolysis and all the solvent regenerated will be classified as electrochemical.

The principal processes of the hydrometallurgical group are:

Siemens-Halske process, using ferric sulphate as the solvent.

Keith process, using ferric sulphate and sulphuric acid.

Tosizza process, using sulphuric acid.

Hopfner process, using cupric chloride in connection with sodium chloride or calcium chloride.

Greenawalt process, using hydrochloric acid with sodium chloride and sulphur dioxide added.

In all these processes, where sulphate solvents were used, an attempt was made to precipitate pure copper by electrolysis and regenerate all the solvent required in the process. In the processes that used a chloride solvent, the object was the same, except that the chlorine required to maintain the solvent was added in the form of sodium chloride.

The principal reasons why these processes have not been successful are: (1) No comprehensive method of chemical control was worked out, and consequently there was an accumulation of impurities in both the electrolyte and the solvent, which necessitated discarding a large percentage of the solutions carrying copper. These impurities in the electrolyte also resulted in depositing impure copper, with great loss of power. (2) Complicated and expensive plant, both to build, operate, and maintain. (3) They were not self-sustaining and could not be operated without the support of chemical works or added chemicals.

Two processes of this group, patented before 1909, are of interest and will serve as illustrations. The inventors endeavored to treat copper ore without added chemicals or precipitants, other than those produced by electrolysis in the process of extracting copper from the ore.

The first of this group was patented by Body in 1883 and the second by Laszynski Brothers, used at the Modzianka mine, in Poland. In the Body process the ore itself is treated in the electrolytic cell where the solvent is produced by electrolysis and copper extracted from the ore and precipitated, all in the same operation. In the Laszynski process the ore is roasted, then leached in a separate tank and the copper precipitated in a specially constructed electrolytic cell with the anodes inclosed in cloth. The procedure has been described by Hofman, on page 414 of his "Metallurgy of Copper."

In the Body process the basic and fundamental principle embodied in the precipitation of any metal from solution by electrolysis is disregarded. The neglect fully to recognize the importance of this basic principle in electrolysis has been one of the main reasons why all electrochemical processes failed. The basic principle is that the metal to be deposited must always stand lower in the electrochemical series than any other metal in the electrolyte and be sufficient to carry the current so as not to increase the voltage to equal the decomposition voltage of any of the other metals in the electrolyte higher in the electrochemical series than the desired metal, as the electromotive force is proportional to the chemical affinity. In an electrochemical process like the Body process, where the metal is deposited from the solvent as fast as it is dissolved from the ore, it is impossible to carry a sufficiently low current density to deposit pure and firm metallic plate, because other elements in the electrolyte besides the desired metal are necessary to carry the current, and they are deposited or partly deposited with the desired metal, resulting in a loose impure metallic precipitate, and great loss of power.

The Laszynski process is a type of electrochemical process on which many experiments have been made. The object desired was to precipitate copper by electrolysis and regenerate the desired solvent without forming other active solvents which would redissolve the copper being deposited. When this class of process used a sulphate solvent the object was to prevent the formation of ferric sulphate and when a chloride solvent was used, to prevent the formation of free chlorine, both of which are active solvents for metallic copper. To prevent the formation of these undesirable solvents the experiments all embodied the use of permeable diaphragms, or their equivalent, placed between anodes and cathodes in the electrolytic cell, permitting the passage of the electric current, but preventing the mixing of the electrolyte in which the anodes and cathodes are immersed, dividing the electrolyte into an anolyte and catholyte.

Ferric sulphate is formed at the anode only and will not pass through the diaphragm to the cathode compartment if the level of the solution in the cathode compartment is kept at a higher elevation than that in the anode compartment. Under these conditions the copper is deposited at the cathode free from the dissolving

action of the ferric sulphate formed at the anode, and, in like manner, when a chloride electrolyte is used, free chlorine is formed at the anode, and if means are provided to draw it away from the cell as fast as it is formed, copper being deposited at the cathode is not dissolved by ferric chloride or free chlorine. The efforts made to control the process by this means are wrong in principle and do not attain the desired result, for the following reasons:

An injurious amount of iron never should be allowed to go into solution. This should be controlled in an earlier step in the process. A chloride solution never should be used. In depositing copper from a solution containing iron, by this method, part of the iron is always oxidized to the ferric state, and as the solutions pass out of the electrolytic cells they must always be mixed, as they cannot be economically discarded. The result is in a short time that all the solutions contain an injurious amount of ferric compounds. Iron and other impurities in the ore continuously increase in the solution and seriously interfere with the efficiency of both the solvent and the electrolyte, and also result in great loss of power and large consumption of solvent taken up by the impurities.

The accumulation of iron in the electrolyte is the most injurious and has been the most difficult problem to control in developing an electrochemical process for copper ores. The same problem of electrolyte impurities arises in treating zinc ore electrochemically, but in this problem all the impurities that affect the deposition of zinc from solution by electrolysis stand lower in the electrochemical series than zinc, and therefore they can all be precipitated by adding metallic zinc dust to the solution under proper conditions. This method, however, cannot be used in precipitating iron and aluminum from a copper solution without precipitating the copper, because these metals stand higher in the electrochemical series than copper, and therefore no metal can be added to the solution to precipitate them without precipitating copper.

The Mackay Process

The Mackay process is an electrochemical process, differing from other processes of this class in that no impurities can accumulate in the solvent of electrolyte, and it does not need to be supported by outside chemicals or chemical works.

In starting a plant using this process the crushed and roasted ore is leached with water to dissolve the copper, combined as sulphate. This solution is used until it contains about 3 per cent of copper. It is then electrolyzed until about 50 per cent of the copper in the solution is deposited as metallic copper and the equivalent of sulphuric acid formed. This solution circulates in a closed circuit through the ore on the one side and electrolytic vats on the other, until all the copper is dissolved from the ore and precipitated as metallic copper, and the combined acid is regenerated as free acid in the solution. The impurities of the ore are prevented from fouling the solution and electrolyte principally by controlling the roasting so that impurities like iron are made practically insoluble in a weak solution of sulphuric acid. And if small amounts of iron or aluminum go into solution in leaching the ore, they are precipitated and the acid combined with them is recovered by leaching the ore with a neutral solution, the iron in the solution being oxidized, either by electrolysis or any other oxidizing agent, such as air.

The process is a simple one, and its practical operation in treating copper ores can best be understood by giving the details of the steps employed in the practical operation of a plant, with sufficient theory relating to some of the features of the process to make the principle on which it is based understood.

The ore is first crushed to ¼ in. and then roasted. The best type of furnace to use is the round multiple-hearth furnace of the Wedge or MacDougall type. Very good results can be obtained with these furnaces in their present standard form by controlling their operation. The temperature required to form soluble copper also forms a small percentage of soluble iron. To overcome this difficulty the soluble iron formed in the upper hearths of the furnace is oxidized to the insoluble compound of ferric oxide in the lower hearths without forming insoluble compounds of copper. This is done by raising the temperature and adding air and burning fuel in the two lower hearths.

In special cases where the products from burning producer gas would mix with the sulphur gases going to the acid chambers, the burning producer gas can be drawn off from the two or three lower hearths and discarded through separate flues.

Where there are a number of standard furnaces already installed in a plant, they can be used without change (other than placing pyrometers in the various hearths) by using one furnace to oxidize the iron in the roasted product from several furnaces, as it is only necessary to complete the roasting in two steps under separate control. The only objection to this method is that the ore loses heat in passing from one furnace to the other and also the extra cost in handling the ore.

Modifications Recommended in Standard Furnaces

The modifications required to be made in a Wedge or MacDougall type of furnace to make it more susceptible to control, are as follows:

Temperature can be controlled by firing with oil or producer gas in each hearth when treating siliceous ores, and in the two or three lower hearths when treating sulphide ores.

Flues for the hot gases should be provided in the walls of the furnace with control dampers arranged so that the gases can be directed into any hearth or bypass any hearth. With this arrangement the temperature can be perfectly controlled in any part of the furnace with a minimum fuel consumption.

In all standard furnaces of the Wedge-MacDougall type the ore is rabbled from the outside to the center on one hearth and from the the center to the outside on the next. The ore falls from one hearth to the other through the hot gases and fire, a distance of about 2 ft. or a little more. This is a serious objection in roasting for electrochemical treatment. In the first place, the heat from one hearth passes to the next, through these ore openings, and prevents separate heat temperature control in each hearth. A second objection is that small particles of sulphide, falling through the hot gases and flame, get overheated and form insoluble compounds of copper; and a third is that the falling ore produces a large amount of dust. The ore should pass from hearth to hearth in closed chutes on the outside of the hearth built into the walls of the furnace and in the center through a circular opening built around the central shaft. These chutes should be so proportioned that they will remain full of ore all the time during the operation of the furnace, arranged so that at the delivery end the

ore will be delivered on the hearth below at such an angle of repose that the rabbles will remove and spread the required amount at each revolution. The lower temperature required in roasting copper ores makes this arrangement practicable, because the ore never sinters or forms in lumps to stop up the ore chutes, but small openings should be provided to give access to these chutes from the outside of the furnace for safety. (See Fig. 1.)

The furnace should be constructed so that thermo-electric pyrometers can be inserted in the ore on each hearth just under the level of the rabbles. The pyrometers should be connected to multiple recording instruments.

Extra rabbles should be provided to stir up the ore more thoroughly. Also, the rabble arms of the furnace should have a varying speed control, and be air cooled.

The most economical size furnace to use is a seven-hearth, 20-ft. inside diameter, with a drying hearth on top outside. A furnace of this size, of the MacDougall type, modified as above described, will roast from 50 to 75 tons of siliceous copper ore per twenty-four hours and less for sulphide ores—depending on the character of the ore—and can be adjusted so that it will produce an automatically roasted product from a 2 per cent ore that will average more than 90 per cent soluble copper and less than 0.05 per cent iron soluble in 2 per cent acid.

Theoretical Principles of Roasting

The molecular heat of formation of cupric sulphate is about 197,500 calories and of ferrous sulphate about 264,000. By taking advantage of this well-known fact, cupric sulphate can be formed in the presence of iron without forming ferrous sulphate, but in practice, on a working scale, the control of the working conditions cannot be adjusted to such an extent that no ferrous sulphate is formed.

Ferrous sulphate begins to decompose at about 500 deg. C. and is entirely decomposed at about 590 deg. C.; and cupric sulphate begins to decompose at about 580 deg. C., and is not entirely decomposed until a temperature of 700 deg. C. is reached, so that ferrous sulphate can be decomposed to ferric oxide in the presence of cupric sulphate. In roasting copper ores to be treated by an electrochemical process, the roasting operations should be controlled to take advantage of these reactions. When this is done the problem becomes simple.

Using a modified MacDougall furnace, as above described, the roasting operations should be conducted in two steps. In the upper hearths of the furnace the ore should be given a semi-sulphating roast, to form as much cupric sulphate as possible and as little ferrous sulphate. In the next three hearths (or the fourth, fifth and sixth hearths)—or the fifth and sixth in roasting sulphide ores—the ore should be given an oxidizing roast to oxidize the ferrous sulphate formed in the first three hearths to insoluble ferric oxide, using the seventh hearth as a cooling and oxidizing hearth. The temperatures (Centigrade) in the various hearths should be about as follows: First, 420 deg.; second, 450; third, 490; fourth, 550; fifth, 590; sixth, 590; and the seventh, approximately in cooling, 450 deg.

The air supply to the first three hearths should be such that a slight pressure is formed in these hearths, regulated in practice so that in opening a peephole in the furnace door air will flow out and not in. The furnace should be regulated so the air supply on the fourth, fifth, sixth, and seventh hearths (or the fifth, sixth and seventh in roasting sulphide ores) should always pass in as fresh air when a peephole is opened in the furnace door; in practice, in excess of what is actually needed to oxidize the iron.

To get the best results and economize fuel, this air for oxidizing should be the fresh hot air returned from the air-cooling system of the furnace. The furnace should preferably be driven by a Reeves variable-speed drive and its speed should be 90 to 270 seconds per revolution.

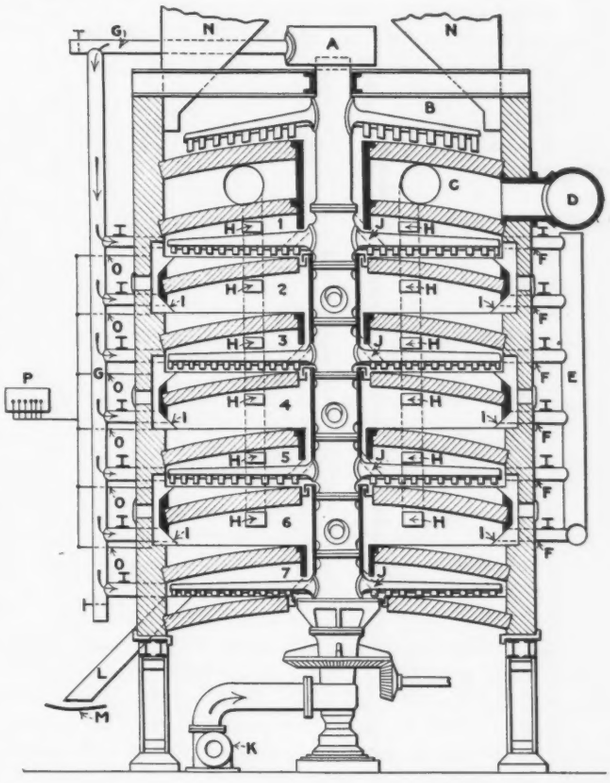


Fig. 1—Section of furnace

A—Hot-air chamber.
B—Drying hearth.
C—Gas chamber.
D—Down-take to chimney.
E—Producer-gas main.
F—Producer-gas burners (two each hearth).
G—Hot air for oxidizing (two each hearth).
H—Hot gas flues, four sets.
I—Hot-ore chutes.
J—Hot-ore chutes.
K—Blower for air-cooling arms.
L—Ore-discharge chute.
M—Asbestos belt conveyor.
N—Ore hoppers.
O—Pyrometers.
P—Pyrometer indicator.

In roasting copper ore containing iron in any amount, in the presence of sulphur, in a MacDougall furnace, controlled as above described, the percentage of cupric sulphate and oxide will vary in accordance with the copper contents of the ore, but the total insoluble copper will average from 0.05 to 0.20 per cent; the percentage of iron soluble in 2 per cent sulphuric acid will be about as shown in the following table:

	Per Cent Soluble Iron	
	Siliceous Ores	Sulphide Ores
First hearth	0.30	0.40
Second hearth	0.25	0.60
Third hearth	0.18	0.80
Fourth hearth	0.10	0.60
Fifth hearth	0.06	0.30
Sixth hearth	0.03	0.15
Seventh hearth	0.002	0.05

Leaching Plant and Leaching

The hot ore is received from the furnaces by a belt conveyor—woven asbestos "Ferodo belt"—running on ball-bearing rollers. When the ore is properly cooled on

this conveyor it is received on an ordinary belt conveyor system which conveys it to the leaching tanks.

The roasted ore is placed in acid-proof tanks by loading the tanks in the center in a cone-shaped pile, allowing the coarser particles to roll down the sides of the cone to the bottom, and spreading the top of the cone with a mechanical spreader. It is an advantage to add a neutral solution in the leaching tanks with the ore, always keeping the top of the ore a foot or two above the solution. (A neutral solution is used to prevent impurities being dissolved from the ore during the time the tank is being loaded.) This method always keeps the ore thoroughly wet and tends to prevent channeling when the leaching operations begin.

The ore should be leached by downward percolation with a 2 per cent solution of sulphuric acid. The leaching tanks are best made of reinforced concrete lined

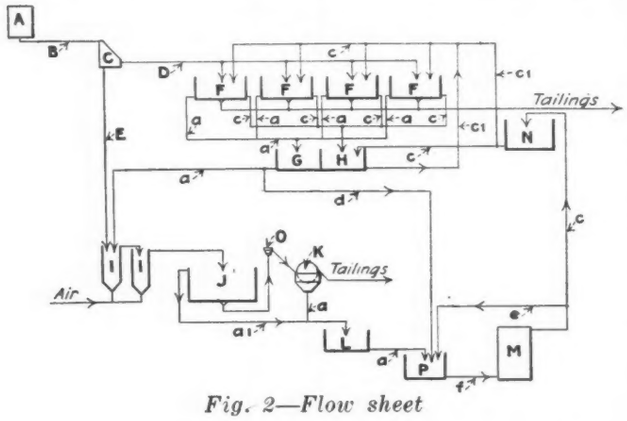


Fig. 2—Flow sheet

with lead or acid-proof bricks, with pitch or asphaltum between the bricks and the cement, or they can be made of wood, lined with lead. They can be built more economically by having them round, of the diameter and height required as determined by experiment. In round tanks, the loading and unloading can be done economically with the belt conveyors, spreader, and excavators of the Blaisdell system.

When iron accumulates in the electrolyte so that it contains 0.50 per cent, the current efficiency in precipitating copper from a sulphate solution is reduced about 8 per cent, or to 92 per cent of the theoretical; therefore iron should never be allowed to accumulate in the solution above this amount. Aluminum also accumulates in the solution, but does no harm, except causing a loss of acid. To precipitate the iron and aluminum and recover the acid, it is only necessary to leach the ore with neutral solution after the iron is oxidized by electrolysis or in the presence of air or any other oxidizing agent. This is most economically done by agitating the solution with air and fine-roasted ore screened out of the general ore charge as it passes from the hot ore conveyor to the ordinary belt conveyor system of the plant, and bypass these screenings to agitators, which form a part of the leaching plant, or oxide of copper furnished from an outside source can be used. These screenings, or oxide of copper, should pass about a 25 (1 mm.) mesh screen and preferably be agitated in Pachuca tanks or similar agitators. The ferrous sulphate is oxidized to ferric sulphate in presence of copper oxide in the ore fines, which acts on the oxide and forms copper sulphate in the solution and precipitates iron. Aluminum sulphate acts on copper oxide in like manner and precipitates aluminum hydroxide, and thus when the copper sulphate so formed is electrolyzed, the acid is recovered.

Fig. 2 is a flow sheet of the leaching plant. *A* represents the furnace, *B*, the cooling conveyor, and *C* the screening plant, where the required amount of ore is screened out to be leached with the neutral solution. The fine ore then passes over the conveyor *E* to the agitator *I;* the oversize from the leached ore passes on to the leaching tanks *F F*, over the conveyor *D*. The 2 per cent solution of sulphuric acid is delivered through the line *C*. These leaching solutions of weak acid become neutral in leaching fresh ore. The solutions are then drawn off at the bottom of the leaching tanks through the line *a* to sump tank *G* and are tested for acid. As soon as they become acid, the neutral line is closed, and the acid line *C* is opened, and the solutions are then drawn off through this line to sump tank *H*. If iron increases in the solution to a point where it contains 0.50 per cent total iron, part of the neutral solution is run into the air agitators *I I* and used to leach the fine ore screened out of the main ore flow and the remainder of the neutral solution goes directly to the electrolytic plant *M* through lines *d* and *f*. The amount of iron and aluminum precipitated in the agitators *I I* and thickener *J* should equal the amount accumulating in the solution from leaching in tanks *F F*.

The chemical reactions which take place in a solution containing $CuSO_4 + Al_2(SO_4)_3 + FeSO_4$, when agitated with air in the presence of copper oxide (CuO), are as follows:

$$6FeSO_4 + 3H_2O + O_3\ (Air) = 2Fe_2(SO_4)_3 + 2Fe(OH)_3$$

$$2Fe_2(SO_4)_3 + 6CuO + 6H_2O = 6CuSO_4 + 4Fe(OH)_3$$

$$Al_2(SO_4)_3 + 3H_2O + 3CuO = 3CuSO_4 + 2Al(OH)_3$$

$$3CuSO_4 + 3H_2O + \text{electric current} = 3Cu + 3H_2SO_4 + O_3.$$

By this process many oxidized copper ores can be treated successfully without roasting provided part of the sulphuric acid is furnished from an outside source.

The flow of the neutral solutions and ore through the agitators *I I* is regulated so that all the soluble copper is dissolved from the ore and the iron and aluminum is precipitated in a continuous flow. The leached ore and solution passes into the thickener *J* and the clear solution is drawn off from this thickener through line *a*1 to a sand filter tank *L*.

When the residues and solutions accumulate in the thickener in such proportions that clear solutions cannot be drawn off the top of the thickener, the residue in the thickener is drawn off from the bottom by pump *O* to the filter press *K*, and the solution and pulp flow from the agitators *I I* is continuous.

The clear solutions from the filter press *K* join the clear solution flow from the thickener and pass through the sand filter *L*. The filter cake is washed, the wash waters going into the solutions. The residues are discharged. The sand filter *L* removes any sediments remaining in the solution, which then flows into the storage tank *P*. The neutral solution in the tank *P* is standardized before electrolyzing by adding acid solution from the electrolytic cells and is returned through line *e*. The standard electrolyte then passes into the electrolytic cells *M*, where part of the copper is deposited and acid formed. Part of the acid formed passes through line *c* to the storage tank *N*, and part to the standardizing tank *P*.

From storage tank *N* the acid solutions can be used directly to leach the ore in tanks *F F* through line *c*1

or to standardize the acid solutions in the sump tank *H* through line *c;* and the acid solutions from this sump tank can also be used to leach the ore in tanks *F F* through line *c*1. By this arrangement, weak acid solutions can be used from sump tank *H* to leach fresh ore and produce neutral solutions. The solutions are circulated throughout the plant with air lifts to aid in oxidizing the ferrous sulphate to ferric sulphate.

To prevent the oxidation of iron, air should not be allowed to come in contact with the ore after it is leached and before it is washed, and acid solutions should not be used as wash waters.

Washing the Leached Ore

In an electrochemical process, it is necessary not only to keep impurities from accumulating in the solution but also to keep the solution from accumulating in the plant. Therefore, the problem is to wash the dissolved copper out of the leached ore as thoroughly as possible without increasing the volume of the solution or the impurities in the solution.

When the ore is leached and the solution drawn down until it begins to disappear below the top of the ore, close the solution outlet at the bottom of the tank and add fresh water at the top of the ore, at first gently, to prevent the water and solution mixing, and, after there is a few inches of water on the top of the ore, the flow of the water can be increased gradually, until the weight of the water added is equal to about 20 per cent of the weight of the ore charge. Then open the solution outlet at the bottom of the tank and allow the solution to run a little slower than the normal leaching flow. In this way, under proper conditions, the column of water on top of the solution in the ore will replace the solution so that the residues, when thoroughly drained, will carry not more than 0.02 per cent water-soluble copper. The amount of water that it is necessary to add varies with the ore, but has been found to be from 18 to 23 per cent of the weight of the ore, 20 per cent being a fair average. Whether all this wash water can be added to the stock solution or not depends on the solution losses in the plant by evaporation. Adding all the wash water to the solution increases the solution volume in the plant from 10 to 15 imperial gallons per ton of ore treated. The last part of this wash water should not carry more than 0.02 per cent copper. This excess solution should be drawn off separately and evaporated, and the crystals of copper sulphate added to the solution, or precipitated on iron and the precipitates smelted, or oxidized and redissolved in acid and precipitated by electrolysis.

The electrolytic deposition of copper from a sulphate solution is a simple matter, using pure solution. Impurities should be prevented from going into solution or should be precipitated before electrolysis. Also, there must always be sufficient copper in the electrolyte to carry the current and the electrolyte should carry sufficient free acid and be kept at such a temperature (about 45 deg. C.) as to make a good conductor, and also be circulated for the reason before given.

An electrolytic plant should be so arranged that the neutral solutions coming from the ore can be conveniently mixed with the acid solutions produced by electrolysis before entering the electrolytic cells. This mixture should contain about 2 per cent copper and from 1.5 per cent to 2 per cent free acid when carrying an average current density of about 10 amperes per square foot of cathode surface. This can best be arranged by having the electrolytic building constructed with a basement story in which sump tanks are placed just under the electrolytic cells arranged on the floor above. These sump tanks are connected in a closed circuit with the electrolytic cells and the solution is circulated by means of acid-proof centrifugal pumps with a regulated overflow.

The electrolytic cells should be connected to the circulating system in parallel, so that each tank is a separate circulating system. Tanks should never be connected in series so that the solution is discharged from one tank to the other in a cascade form, for if this is done, an electrolyte of the highest efficiency cannot be maintained, because the copper and acid in the electrolyte are continuously varying from tank to tank, and as the current density is fixed an electrolytic equilibrium is not maintained.

The electrolytic tanks should be constructed of wood lined with lead or of reinforced concrete lined with acid-proof brick, and each tank should contain from three to seven electrolytic cells. About 2.2 volts should be allowed per tank, including losses in conductors and contacts.

The electrodes in the tanks should be electrically connected in parallel and the tanks in series, and placed parallel to the sides of the tanks. The electrolyte should flow in one end of the tank and through and between all the electrodes, and discharge at the other end. There should be two perforated lead diaphragms, one at each end of the tanks, to assure a uniform flow of electrolyte.

The solution should be circulated through lead or earthenware pipes with goosenecks at the inlet and outlet of the tanks, arranged so that the main solution pipes are insulated from the tanks and the tanks from the building and ground. The flow of electrolyte through the tanks and cells should be such that a drop in copper in the electrolyte should be from 0.30 to 0.40 per cent. The anodes should be made of lead containing about 3 per cent to 5 per cent antimony and be about ¼ in. thick, about 1½ in. narrower than the cathodes and 1 in. shorter, and anodes should be placed about 3½ in. apart on centres, and provided with porcelain insulators to keep the anodes and cathodes in perfect alignment throughout.

Cathode starting sheets should be made in cells especially provided for this purpose. The starting sheets are made by precipitating copper on lead blanks of the same composition as the anodes. These blanks are oiled, so that when the copper is deposited it can be stripped off. Wooden strips should be placed on the edges and bottom of the blanks so the starting sheets formed can be conveniently stripped off. The starting sheets are trimmed, and straps are riveted on them to provide means to hang them to the cathode bars. These strips are also made from starting sheets.

A traveling crane should be provided running over the electrolytic tanks to handle the copper cathodes and lead anodes with hook connections, so that all the electrodes of one cell can be removed or replaced in one operation. The cathodes should be washed with hot water before they are shipped or melted down, to remove any soluble sulphates.

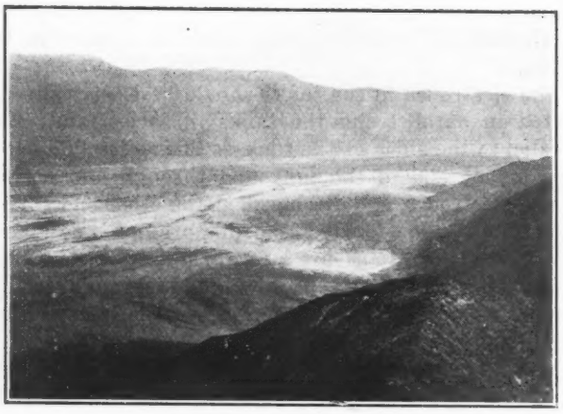
A plant using this process has been designed by the author to be built in Australia. This will treat 500 tons of siliceous ore, containing 4 per cent copper, per day.

Through Death Valley on the Fourth of July

The Tale of a Night Ride to a Prospect in the Funeral Range, California—Bennett Wells, an Oasis of the Desert

By H. R. Van Wagenen
Mining Engineer, Los Angeles, Calif.

THE PERFECTLY GOOD EXCUSE for such a seemingly questionable journey as a trip through Death Valley, in California, in the month of July, was a short option on an interesting prospect. My partner and I decided to sever connections with civilization at Ryan, where is the principal mine of "Borax, Ltd.," successor to Borax Smith and his famous twenty-mule teams. This property, at the end of the railroad, is situated on the western slope of the Grapevine Mountains. These adjoin the Funeral Range, the two constituting the eastern wall of Death Valley; the Panamint Mountains



Looking into Death Valley from Funeral Range. The white areas are salt. Panamint Range in the dim distance

are the western boundaries of the valley, which is a long north-south syncline, whose present bottom is 300 feet below sea level.

Ryan is a pleasant camp. Orderly, substantial, clean, and with paint on it. Its setting is picturesque. A steep mountain slope, all rocks, many colors; bands of white and cream amid the general blackish tenor of the basalts; shades of green and pink, too. None of the beauties of these strangely tinted rocks are hidden behind verdure—there is none.

But in July it is hot there—not red hot, just a dull cherry (thanks to its 3,000 ft. of altitude). However, broad verandas, canvas awnings, non-glare paint, and an ice plant do much to alleviate the natural conditions and to make the place livable for the crew of sturdy men and a few courageous families who try not to look at the thermometer too often. The whole is dominated by the genial and strong spirit of its soldier manager, Major Boyd, whose experiences in the Egyptian and Mesopotamian campaigns admirably prepared him for the responsibility of sustaining life in one of the world's hottest and most desert spots.

We filled "Lizzie" full with all the liquid refreshment she was built to hold, and then loaded on twenty gallons more, ten of gas and ten of water. On comfortable beds, but with all bedding cast aside, we made a poor stab at getting a little sleep—which degenerated into a Turkish bath; then, at midnight, the watchman roused us, and we hopped off into the silent, hot darkness.

Our road led down Furnace Creek. With each succeeding drop in altitude, the atmosphere became more oppressive. The Furnace Creek Ranch was reached at 1.30 a.m.; a last shot of water was taken aboard, and then we passed on out into the open valley. Here the oppressiveness of the air was somewhat relieved by the breeze that blows every night, due to the gradual displacement of the hottest layer of air in the bottom, by the coo'er and heavier draft that sinks down from the surrounding mountains. Yet the change did not make it refreshing. Far from it. No more vivid description of its quality can be given than the comparison of the outrush of heat from an open furnace door. It was parching hot, and one experienced almost continuous thirst by reason of the steady loss of body moisture through the evaporation of perspiration.

"Abomination of Desolation"

The "sink," the very bottom of the valley, is a surface of salt, with hundreds of feet of thickness of salt underneath it. A cracked-up surface it is—looking just like the ice on a broad river at the spring break-up. Mighty rough traveling, and miles of it. No living thing down there, of course; instead, a carcass occasionally, telling the sad story of some poor brute lost from the herds that find the slopes of the valley such a comfortable protection in mid-winter from the heavy storms that periodically visit the surrounding higher regions.

Having crossed the "sink," we gradually ascended a hundred feet or so on its western slope, turned parallel to the valley's axis, and on a very decent road, level and smooth, traveled rapidly with the breeze. Then came a surprise—the water in the radiator began to boil, purely a consequence of that following breeze. The first gray streaks of dawn came, and soon we could see things; some seemed rather queer; for instance, the valley's floor gave the impression of a mosaic of small rocks, swept clean of dirt by that ever-recurring nightly wind. Finally, when we reached the dimly marked trail that led off from the main road and up a gentle slope to the mouth of the canyon of our destination, the first rays of sunlight of the new day broke through the saddles of the Funeral Range. We parked "Lizzie," dismounted, and took a look backward over the road we had traveled. A wonderful but depressing landscape. The valley, its center still draped in the mystery of deep shadow, stretched scores of miles to the north and south in the loneliness of utter desolation, of almost death itself. Yet not quite. What of that little patch of green down yonder, not far from the edge of the salt beds? Bennett Wells! What a story it could tell of those intrepid 'Forty-niners, those courageous pioneers. They, embarked upon an uncharted wilderness, full of unknown and unmeasurable perils, laden with the impediments of a transcontinental trek, moving along at the deadly oxen-pace, beset with hostile Indians and almost at the last extremities, there found water on that the most terrible stage of their journey. Theirs indeed was a courage, a resourcefulness, a faith, the measure of which has perhaps no superior in the known history of modern man. What an example to us, their countrymen of the next generation; what a standard, a mark to shoot at! And, in comparison, how insignificant are the today's hardships of our frontier.

The Chino Enterprise—III

Geology of Santa Rita

By T. A. Rickard

ANYBODY about to study the ore deposits of a district in the United States should ascertain if the U. S. Geological Survey has published anything on the subject, for this is the most direct way of obtaining reliable preliminary information. Santa Rita is within the area covered by the Silver City quadrangle, a folio on which, written by Sidney Paige, was published by the Survey in 1916. This folio therefore, as official geological reports go, is of comparatively recent date.

The district is in an area where the Basin ranges, trending southeastward, and the Rocky Mountains, trending southward, come together. The orographic position of Santa Rita therefore is interesting; and it is significant because the intersection of two major lines of crustal movement ought to favor the formation of orebodies. Another noteworthy fact is that the line of the continental divide, separating the northwestward drainage to the Gulf of California from the south-eastward drainage to the Gulf of Mexico, passes through the district at a point 11 miles west of the town of Santa Rita. This, the map shows, is situated at a place where a porphyritic quartz-diorite has broken through sedimentary rocks, notably shale, quartzite, and limestone. Later volcanism is indicated by the intrusion of granodiorite, or monzonite. Then came a period of cooling and fracturing; after which the sedimentary strata and the older igneous rocks alike were penetrated by dikes and tongues of andesite and rhyolite. Evidently the conditions are such as a miner would consider favorable to the finding of ore.

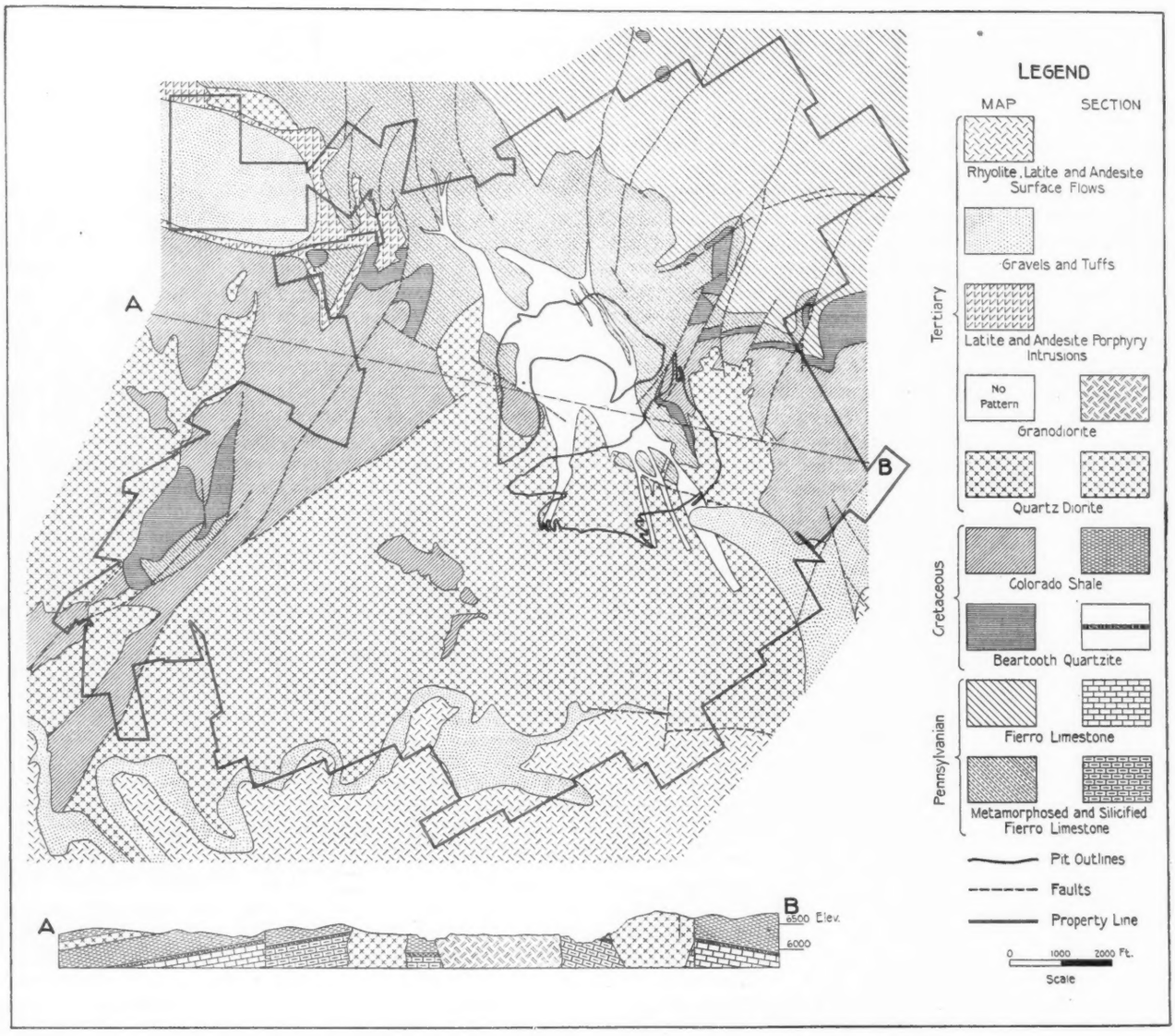
Santa Rita is one of the many important mining districts that are associated geologically with the volcanism of the Tertiary period. The igneous intrusions of that time in this part of New Mexico produced an uplift of the pre-Cambrian rocks and caused block-faulting on a large scale. Later in the same period, after erosion had been at work for a long time, a fresh outbreak of volcanism was signalized by a lavish outpouring of lava, rhyolitic and andesitic. At the end of the Tertiary period and in early Quaternary time, further extrusions, basaltic in character, covered the surface elsewhere in New Mexico, notably the upper Rio Grande valley. These later eruptions have continued in diminishing volume since then; they are important to the student of ore deposits even where no actual extravasation of lava ensued locally, because they were the outward and visible sign of the volcanic and thermal activity underground that is conducive to the circulation of mineralizing waters along the cracks, crevices, and shear-zones created by crustal movement.

"Porphyry" a Mistaken Term

The pre-Cambrian rocks of this part of New Mexico are granite, syenite, and their allied porphyries; but these do not appear at Santa Rita; nor do the older sedimentary strata that elsewhere in the Silver City quadrangle overlie, with unconformities, the basal complex. At Santa Rita the granodiorite, or quartz-monzonite porphyry, has intruded into the Fierro limestone (Carboniferous), the Beartooth quartzite (Cretaceous), and the Colorado shale (later Cretaceous) so as to produce intense contact metamorphism, as well as faulting. The metamorphism has been such as to obscure the original character of some of these rocks. For example, the Fierro limestone has been silicified and impregnated with contact minerals, such as garnet and epidote, so that the miner—and the more sophisticated mining engineer as well—has mistaken it for "porphyry." The Colorado shale has been altered to a blocky porcelain-like rock, which can be distinguished from the porphyry that intrudes into it by the lack of quartz phenocrysts. The blocky cleavage, fine grain, and yellow tint of the weathered rock distinguish this shale from the Beartooth quartzite.

The intrusive igneous rocks also have undergone intense metamorphism, caused not so much by heat or movement as by the action of waters that contained silica, iron, and sulphur, causing silicification and impregnation with pyrite. The quartz-diorite porphyry has been metamorphosed severely by the intrusion of the quartz-monzonite porphyry. This older porphyry, says Mr. Paige, "is not only sericitized but is in places kaolinized. It contains altered feldspar phenocrysts composed of nearly clear colorless kaolin; also very abundant secondary amorphous silica." The monzonite likewise has undergone a similar alteration. "Abundant sericite has formed in the feldspar, the biotite is chloritized, and kaolin is present. Sulphides are especially conspicuous. The rock is much seamed and fractured, but has not received the enormous accessories of silica which seem to have made the surrounding hills of quartz-diorite porphyry so resistant." And, most important, this monzonite-porphyry contains disseminated copper in the form of chalcocite. "The orebodies were formed by the enrichment of a copper-bearing pyrite, which occurred in the closely fractured porphyry and was probably also disseminated through the porphyry lying between the fractures." Evidently the deposition of copper from ascending solutions, during periods of thermal activity following in the wake of active volcanism, was supplemented at a much later date by the deposition of secondary copper precipitated from descending solutions. Mr. Paige concludes his description of the Santa Rita deposits in these words:

"The geologic history of the region throws some light on the enrichment of these orebodies. The intrusions of the quartz-monzonite porphyry type are believed to have taken place about the end of Cretaceous deposition, certainly before the period of erosion that preceded the Tertiary lava flows. The mineralization of the porphyries of the Santa Rita district also took place before this period. Therefore the ores were doubtless enriched to some degree long before the lava floods covered them up and arrested leaching. The time that has elapsed since the lavas were removed has not been sufficient to permit the deep leaching that has occurred at other localities. The ground-water in this region must have stood at a height very different from that which it now occupies (100 ft. from the surface in abandoned workings), for, as stated above, the chalcocite zone descends many hundreds of feet. The



Generalized geologic map and section of a part of the Santa Rita district

original pyritization was caused by solutions which, probably soon after the intrusive mass had cooled, gained access to the porphyry and the inclosing rocks through innumerable fractures whose mode of origin has not been determined."

In regard to the faulting, Mr. Paige recognizes two faults that intersect near Santa Rita: "One passes north-eastward nearly through Cobre siding, and its downthrow on the south is strikingly brought out by the discordance in level of the horizontal lavas which it cuts south of Hanover Junction. The other fault approaches Santa Rita trending almost west. Its downthrow is also on the south, with the consequence that within the angle between these faults only Cretaceous beds occur at the surface."

Prof. E. H. Wells, president of the New Mexico School of Mines, has been engaged recently in a geologic examination of the district, and to him I am indebted for the accompanying geologic map. He informs me that his interpretation of the faulting differs from that of Mr. Paige, it being his opinion that the north-eastward fault near the Cobre siding is but one of a series of parallel faults, which have a downthrow on the south-east side. Professor Wells was unable to find the fault shown by Mr. Paige as approaching Santa Rita with a nearly westward trend. The Beartooth quartzite is faulted only to the extent of a few feet on the east side of the Hearst pit, and the faults that are visible in that part of the mine have a south-westward, instead of a westward, trend. Moreover, the professor insists that not "only Cretaceous beds," but the metamorphosed Fierro limestone also, were present "at the surface" in important ore-bearing areas, although he acknowledges that much of the limestone was obscured by débris.

Sully's Work Forgotten

The only reference made by Mr. Paige to Mr. Sully's study of the geology of Santa Rita is a mention of some diamond-drill holes for which Mr. Sully was responsible; there are plenty of references in the folio to Mr. Paige's learned associates on the Survey, but the mining engineer that broke the scientific trail of geologic investigation is ignored. This is characteristic of the writings of many of the officers of the U. S. Geological Survey; they accept eagerly all the

data collected by engineers in the course of prospecting, or management, or examination of mines in a district, but when the time comes for the official geologist to write his folio, professional paper, or monograph, he ignores the work of men on whose pioneer efforts his own brochure has been built. This is an old story; it is a blemish on the reputation of the U. S. Geological Survey, and it is time that the gentlemen at Washington turned over a new leaf of larger generosity and fairer acknowledgment. A. C. Spencer, I believe, is preparing a further report on Santa Rita for the Survey. I invite him to pay his respects to Mr. Sully in proper terms.

Mr. Sully's ideas of Santa Rita geology were in print—in Lawson's prospectus of 1909—long before Mr. Paige went to the bat. The engineer that made the thorough and comprehensive report on the Santa Rita mines had made a careful study of the local geology and his findings were at least as pertinent as those of Mr. Paige. Mr. Sully recognizes and describes the two principal intrusive rocks, the older one of a granitoid type and the younger quartz-diorite. He describes the surficial flows of andesite and the rhyolitic lava of still later geologic date. He traces the shape of the syncline that forms the Santa Rita basin and outlines the intensive faulting with which the formation of ore is so intimately associated. Santa Rita creek follows the line of a fault. He says:

"The Santa Rita creek has found its course through the basin, approximately along the fault, which, as would be expected, is not by any means a straight line. Two other faults, cutting the main fault at approximately right angles, can be seen, one at the north-easterly end of the basin, crossing the Santa Rita creek fault just below the old mill in a northwest-southeast direction. The Texas Flat and Romero Hill orebodies, the upper end of the Montoya Section, the Air-Shaft orebody, and the Hearst Section approximately mark the line of this fault. The south-westerly fault, nearly parallel to the other, strikes across the Santa Rita creek fault just below Turner's store, and follows in a north-westerly direction the line of the railroad up through Depot Flat, while to the south-east it passes to the north-east of Wildcat Hill. This latter fault has not as yet been prospected to any extent, as the workings of the Chino Section are some 200 ft. to the north-east, while the Lee Hill and Oxide workings are a considerable distance to the southwest. These three major faults, which were probably formed during the period of intrusion of the quartz-mica-diorite, judging from the fact that masses of the sedimentaries are found below the surface of the quartz-mica-diorite and completely surrounded by it, have caused the depression forming the basin, and have furnished the channels to the ground-water flows, while the main mass of intrusive has served as a deflector for holding the ground-water from too much diffusion."

This is a piece of first-rate geological description and gives the keynote to any study of the Santa Rita copper deposits. In regard to metamorphism, Mr. Sully says:

"The metamorphism of the sedimentaries is in evidence. No large garnet areas exist, although some garnet and other metamorphic minerals are to be found. Silicification and marmorosis of some of the purer limestones are to be seen. Silicification is much more general, as the impure beds of limestone are more numerous . . . Another feature of the metamorphic action of the intrusion is in the partial development of a porphyritic texture in the sedimentaries. These porphyroid rocks can be shown by their geological relationship to be altered sediments, and are in evidence along the contacts of the main intrusive."

This was published seven years before the U. S. Geological Survey's folio No. 199, but Mr. Paige makes no acknowledgment, most of his footnotes referring to the previous writings of Sidney Paige, and others to the reports of Messrs. Ransome and Lindgren of the Survey.

Origin of Chino Ore Deposits

As to the origin of the ore deposits, Mr. Sully offers an explanation that is scientific and in accord with modern theories on the subject. He distinguishes the primary from the secondary ore, and traces the relationship between them, thus:

"From the evidence, it is believed that the magmatic water of the deeper circulation caused a primary concentration of sulphides, poor in copper, along the faulted zones. The andesite-porphyry contains pyrite along its edges, as an accessory mineral, carrying some copper values; and along the contact, in the neighborhood of the andesite-porphyry, sulphides exist in the neighboring rocks. Even in the rocks outside the zones of faulting, pyrite is found; and it is to be noted that magnetite is an accessory of both intrusives, while a considerable portion of ferrous iron forms part of the complex silicate minerals of the intrusives. As has already been stated, some of the sedimentary beds themselves show the presence of appreciable quantities of copper-bearing pyrite. It is evident, therefore, that both intrusives and sedimentaries furnished the necessary copper-bearing pyrite, so that the weathering and the denudation would furnish a ground-water solution carrying copper sulphate, and thus permit of the secondary enrichment of the deposits below. It seems scarcely probable that the copper contained in the primary ores is sufficient to permit of its commercial recovery at a profit. What the depth of the secondary enrichment will be on the south-east edge of the basin cannot be stated, but at present the greatest depth from surface is 400 ft., with native copper and chalcocite forming the ore.

"All the necessary conditions for the formation and concentration of orebodies exist in the Santa Rita basin. The anticlinal fold over the Hanover basin, where opportunity was afforded for the entrance of oxidizing waters, continually exposed fresh surfaces through its denudation. Openings made by the fissuring and bedding-planes of the sedimentaries, having a dip toward the Santa Rita basin, formed channels for the flow of these waters, while the probability that a deep valley existed to the south-east aided the tendency of flow in the direction of the basin. These waters, which had dissolved the copper from the sedimentaries, porphyry sills, and contacts generally, in their descent from the crest of the anticlinal fold and faults of Hanover Gulch, eventually reached the barrier of the intruded quartz-diorite with the adhesive porphyry dikes. Here the water would naturally follow the faulted zone, as furnishing the line of least resistance. Some of the waters would follow along the horizontal contact (an irregular line), thus impregnating the upper zone of the broken intruded mass, but following down any fissures or large fault-planes, the copper contents being precipitated by the sulphides

or ferrous iron compounds encountered. That secondary enrichment has taken place is evident; but it is not certain that some of the native copper may not be of the first concentration from the solutions, especially that found in the quartz-diorite and known as shot copper, the native copper in these cases being associated with the hornblende crystals. The mass of the native copper is due to action of the copper solution on the chalcocite."

I have quoted at length, because copies of the Lawson prospectus, although widely distributed among the unsophisticated persons with whom Mr. Lawson expected to do business, are now accessible to few of my readers; moreover, I deem it only fair, in view of the fact that Folio No. 199 ignores Mr. Sully's painstaking and accurate study of the deposits, that he should be given the fullest credit for his excellent work.

Sydney H. Ball's Contribution

Later, in 1910, Sydney H. Ball described the geology of Santa Rita in a report made for the Chino company. He summarizes the geologic history of the locality as follows:

"In Carboniferous time the land now comprised within the property of the Chino Copper Co.'s holdings was a sea in which limy sediments at times containing considerable mud and at others of a siliceous nature were deposited. Sands were later deposited on these calcareous sediments. When lifted above the sea at the end perhaps of Paleozoic times these sediments were consolidated into limestone with associated shale and porphyry and quartzite. In early Eocene time a great mass of diorite-porphyry was intruded into the older rocks and the intrusives at Santa Rita are on arms of this mass. The intrusion was preceded and accompanied by important faulting and its heated waters and gases to an important extent metamorphosed the near-lying limestone series. The intrusion was accompanied and followed by the deposition of cupriferous pyrite and chalcopyrite and tabular masses near the diorite porphyry sedimentary rock contact. Erosion followed and the secondary enrichment of the ores began with the inauguration of this erosion. The surface then sunk and became a lake bed near which were explosive volcanoes which threw volcanic dust into the lake. An andesitic intrusion followed and later the area was successively overflowed by rhyolite and basalt. Erosion again began and secondary enrichment which had been interrupted during the formation of the tuff in the lake re-commenced. The formation of a broad valley about 70 ft. above the present-day valley and the Santa Rita flat in Pleistocene time and the incision into it of the present streams brings the history down to today."

Mr. Ball describes the orebodies as "disseminated contact deposits" and states that they are:

"1. In close relation to the contact of the diorite-porphyry and sedimentary rocks.

"2. Frequently associated with faulting and intense brecciation.

"3. Always associated with either quartzite, metamorphic rocks or altered diorite-porphyry. The chief changes in the latter have been silicification, kaolinization, and sericitization. All three processes result in whitening the rock and partially obscuring the porphyritic texture.

"4. Frequently rich in porous rock underlaid by an impervious rock.

"5. In part determined in position and form by the mineralogical composition of the country rock."

Mr. Ball's geology is better than his writing, probably because he underrates the importance of the writing as compared with the scientific research. It is difficult to understand, for example, how an orebody can be "frequently rich in a porous rock underlaid by an impervious rock." He means, I presume, that the ore impregnates a porous rock and that the downward extension of the ore is determined by an underlying impervious rock. Mr. Sully refers to the siliceous wall rocks that delimit the orebodies. In regard to the genesis of the ore deposits, Mr. Ball says:

"Original deposition: At the time the diorite porphyry was intruded two of the constituents of the metamorphic rocks then formed were chalcopyrite and cupriferous pyrite. The main deposition of these original sulphides was of somewhat later date. The heated gas and solutions rising from the diorite porphyry deposited the sulphides in fractures and they also replaced the country rock.

"Secondary enrichment: The original sulphide ores were later enriched by descending and laterally moving waters. The chalcocite and rich copper oxides and carbonates were formed by this process. The following zones from the surface downward are superimposed one upon the other:

"(1) A thin unimportant leached zone.

"(2) A zone of oxidized ore (carbonates and oxides about 150 ft. thick).

"(3) A zone of secondary enrichment with base from 400 to 1,000 ft. beneath the surface.

"(4) Original sulphide deposition."

Mr. Ball describes the principal lines of faulting, previously determined by Mr. Sully, and adds:

"Faulting has continued almost to the present day, since in the south-east corner of the Carbonate claim the terrace gravels and the porphyry are in fault contact; further, oxidized ores such as native copper, malachite and cuprite in rather unusual cases show slickensides."

Mr. Ball explains how the form of the orebodies is determined by economic, rather than structural, conditions:

"The contact disseminated deposits of the Chino Copper Co. are tabular orebodies lying in both the sedimentary rocks and the diorite-porphyry near their mutual contact. They grade peripherally into mineralized ground which carries too low copper values to pay mining, milling and smelting charges. As here used, an orebody is a mass of rock containing at least 1½ per cent of copper and of sufficient tonnage for profitable extraction. The form of the Chino orebodies is hence more or less arbitrary and is ruled by the costs of mining. Thus if the price of copper doubles or mining costs were cut in two, the 'orebodies' at Santa Rita would not only be changed in form but also increased in acreage and tonnage. Surrounding the orebodies is rock containing some copper, but less than 1½ per cent, and this will be referred to as in the 'mineralized area.' "

This mineralized area covers ground into which the mining operations of the company will be extended as and when the price of copper increases or the cost of production decreases. I regret that space does not permit me to quote Mr. Ball further on this interesting

topic. His report is detailed and complete; it shows evidence of painstaking observation and careful study —I say this lest my reference to the literary presentation should seem to convey depreciation of its technical matter. That is not my intent, which is to emphasize the need for giving more care to the writing of such reports.

Professor Wells informs me that the "diorite-porphyry" of Ball's report includes both the quartz-diorite porphyry and the quartz-monzonite of Paige's folio. Similarly, the "quartz-diorite" of Sully's report includes both of these rocks. The "andesite-porphyry" of Sully and of Ball is not mentioned by Paige, probably because the dikes of this rock are too small to be shown on his map.

S. F. Emmons, writing in 1899, refers[1] to the Santa Rita copper deposits in these words:

"My judgment was, that most of this ore had been formed by leaching down from the low-grade pyritous body in the limestones which once covered the porphyry. Considerable bodies of hematite ore, evidently the result of oxidation in place of bodies of pyrite, are frequent in the limestones of this region; and, in the Hanover mine, it is said that copper ore has been found in the pyrite immediately under the hematite."

My own notes are merely supplementary to the descriptions that I have quoted from those who went before me. Outside the office at Santa Rita lies a piece of typical ore, weighing 400 lb. It shows dark veinlets of copper sulphide and also of cuprite that has been weathered to melaconite. Abrasion discloses patches of native copper. Parts of the ore have the green tint due to impregnation with copper oxides. The rock matrix seems to be silicified limestone; in places it includes silicified fragments of an intrusive rock, probably granodiorite.

In the Romero pit I noted a dike of andesite, 35 to 50 ft. wide, that crosses an orebody marked by beautiful patches of chalcocite and native copper. Looking at the face of the open cut, one can distinguish the dull-drab green of the Fierro limestone from the light-gray quartzite, the latter being well mineralized and enriched near the contact with the dike, which also is gray, but it has a blocky fracture and weathers to light brown. It contains 6 per cent of free quartz, and so is a quartz-andesite, or dacite. The ore shows the green stains of copper and prills of native metal along the cracks; and in the body of it are specks of chalcocite. As the Mexicans say, it is *mosceado* (from the Spanish *mosca*, a fly). The native copper varies in color from yellowish red to purple and then to the green of further oxidation. As the eye of the visitor becomes trained he has no difficulty in distinguishing the red patches and sheets of native metal, the dark blotches of chalcocite, and the threads, or *hilos* as the Mexicans call them, of black sulphide—not all chalcocite, some of it being bornite.

Water was issuing on the floor of the open cut, and was said to rise from a depth of 300 ft. At the time of my visit the ore carried 4 to 5 per cent of water only, because the mine had been idle and the weather was dry, but normally the ore carries 8 to 10 per cent water, the orebodies being saturated with moisture.

On the morning of May 20, 1922, the superintendent, Harry A. Thorne, reported a find of high-grade ore in one of the working faces, so Mr. Sully and I accompanied him to the spot, at the west end of the South orebody, close to drill hole No. 274. We waited until the steam-shovel had finished loading the train of seven cars, meanwhile watching it digging manfully into the broken ore, puffing, rattling, and straining with the nominal energy of a hundred horses. It was a model No. 92, Marion, with a 3½-yd. dipper. In twenty-five minutes it filled the train, with a capacity of 280 tons of broken ore, equivalent to 140 cu.yd. of rock in place. "Almost human" it seemed in its operations, for while watching a machine we are inclined to forget the brain of the man that is controlling its motions. We descended into the pit and examined a handsome piece of ore showing threads of glittering black chalcocite, with an edge of green, between bands of red cuprite, fringed likewise by the green carbonate. The ore was in the diorite-porphyry, close to a contact with the later granodiorite intrusion, which has fingers running north and south, for a width of 700 ft., and traversing all the rocks, even the youngest (the rhyolite), which forms the escarpment of Santa Rita mountain. Another series of fractures identified with the Central orebody crosses the other systems of fracturing in this locality, thereby making conditions particularly favorable to the deposition of ore. The drill holes showed first oxidized ore, then native copper, then sulphides with the native metal.

On the afternoon of May 23 I went to see another high-grade "streak," reported as having been found in the Hearst pit. I crossed the northern end of the big open-cast workings, where nothing was being done. The bigness and the quietness were impressive, for the scene suggested former intensive activity and noise. Eight tiers of benches stood warm in the sunlight, in many colors—white, red, green—with a reddish brown rock capping the orebody and a brown sump at the foot of the cliff of ore—600 ft. from top to bottom. The sweeping curves of these industrial terraces were dominated by the crest of Santa Rita mountain and the fanciful figure of the Kneeling Nun. Under my feet was a well-developed iron gossan. The east face showed clearly the lines of sedimentation in the silicified Colorado shale and in the Beartooth quartzite underneath. I picked up a piece of quartzite rich in native copper, chiefly along the cracks. The altered Fierro limestone is capped by a red irony agglomerate (the Beartooth quartzite). The best ore is in the quartzite; next as an ore-bearer is the metamorphosed limestone, and poorest the Colorado shale and the overlying igneous rock. The face of high grade near drill hole No. 581 showed a 6-ft. vein of beautiful ore, granular, dark gray, mottled by chalcocite in the proportion of 15 per cent. At the bottom of the cut the ore showed a width of 10 ft. It appeared to be in the midst of a barren stretch of ground and had a distinct footwall of diorite-porphyry. Returning southward from this cheerful sight I noted lumps of dry clay in which were roots and other pieces of woody fiber that had been replaced by copper, as cuprite—a suggestion of the reducing action of organic matter. This is illustrated further by a pile of old timbers lying outside the general office. These timbers were taken from the Spanish workings; they assay as much as 16 per cent in copper, and average 7 per cent. When found, in the course of steam-shoveling, they are collected in the pit and burned to extract the metallic copper that has been precipitated in them.

To be continued

[1] "The Secondary Enrichment of Ore Deposits," *Trans.* A.I.M.E., Vol. 30, p. 194.

Educating the Prospective Mining Engineer

Specialization of Study and Opportunities for Successfully Applying Knowledge Gained in School—His Apprenticeship

By Jay A. Carpenter
Mining and Metallurgical Engineer, Los Angeles, Calif.

THE YOUNG GRADUATE, when he enters the mining industry, must expect to meet with keen competition at a compensation equaling about a miner's pay. Wages and salaries are based upon supply and demand. At present young engineers are plentiful and muckers are scarce. He must expect to rub elbows with the mine and mill laborer before he is advanced to a higher position. The young doctor, lawyer or dentist steps out into practice with the general trappings of the profession, an office, an automobile, and good clothes. These are necessary items. The engineer

Jay A. Carpenter

must first take to boots and khaki. Many ups and downs are to be expected by the young engineer as well as much traveling, due to the vicissitudes of mining. High pay and a good reputation as a worker are, even in the instance of a paying mine, a wasting asset. New connections must frequently be made, and before this can be accomplished, the young engineer finds that his experience with a defunct organization may carry little weight, and his savings are often depleted before he secures another position. Work in subordinate positions and frequent changes in employment characterize this initial experience of the young graduate. Although his apprenticeship may be laborious and uncertain, it is compensated for by its freedom, excitement and travel. The young city doctor, or lawyer, who may have little left after paying rent, high living expenses, and interest on his notes, no doubt envies the salary check and modest living expenses of the mining engineer.

After his apprenticeship has been served, the engineer should have decided upon the special line of work he intends to follow. This may be geological, mining, metallurgical, or promotion work. In the first three, salaried positions that pay well can be secured. The compensation is in proportion to the living conditions and probable length of employment. If he be of the disposition that finds satisfaction in the regular salary check, he will cultivate employment with large mining companies, colleges and state or government bureaus. If the roving spirit is stronger, he will follow the higher salaried positions of uncertain tenure or seek employment in foreign lands, in the hope of more rapid advancement. If he builds up a good reputation as a technical man he will be inclined to follow consulting work. If he becomes a mine manager and enjoys struggling with accounts and cost sheets he will continue with that work or drift easily into other lines of business. The engineer who finds his principal outlet in operating for himself and in promotion, uses both his technical knowledge and his acquired business skill in interesting capital in his ventures and carrying them through to a decision.

Five Years of Preparation Advisable

In my opinion, the opportunities are equal in geology, mining, and metallurgy. As mining becomes more exacting in all of its branches, the chances for success depend more and more upon the graduate specializing on some particular branch and mastering it. I do not believe in developing too high a degree of specialization in these subjects in college at the expense of the cultural subjects. The four-year course of the average mining school should be fundamental on mining, metallurgical and geological subjects and should include a limited number of electives as well as a fair proportion of cultural subjects. The average student is best served by such a general course. Usually he is the young boy direct from the high school. He probably has an engineering bent, but has little conception of mining or the technique of its branches. Upon graduation he is apt to accept the first position offered him, drift from this more or less by chance into other positions, and finally under the stimulus of actual experience he will make his choice of the branch he will follow. Often, however, he continues in the branch in which he was fortunate enough to obtain his best start. A surprisingly large percentage of the young graduates find, after two or more years of actual experience, that they do not like the work and can do better for themselves in other lines.

The four-year college course is too short, and the field of mining too great, to attempt much specialization in a mining engineering course. The young boy who has shown a decided bent for one branch of mining, or the older student who has made his choice after a working experience, will find it best to select all possible electives in the particular subject and take an additional year at the large university or technical school where there are good instructors in that branch.

Most mining graduates will find their first work in

the mining industry in salaried positions as assayers, surveyors, plant and mine foremen, superintendents of small mines and mills, and similar positions. The four-year college course is sufficient training for these men. Those who advance to higher salaried positions do so not as the result of one or two years' more work at college but by years of steady study, reading, and observation in the intermediate positions that they hold.

A diploma indicating the completion of the college course is only a starting point. The best that a man can get from his college is the cultivation of a habit of study that will remain with him. Many a plodding student in college has envied the keener brain of his neighbor, but has passed him in later years as a result of having acquired this habit of study.

For the foregoing reasons, the mining school, especially the small one, should not attempt to give more than a four-year course, and electives should be relatively few in number. The funds of the school should be spent for a high-grade teaching staff and its work restricted to the important courses that best serve the major portion of the student body.

The four-year course should not be confined too strictly to engineering subjects, as the young engineer who leaves college with higher ideals and a liking for the best works in fiction, history, poetry and science is fortified against the monotony of camp life and can acquire a mental growth that will distinguish him from the type of engineer who can only talk "shop." Evenings spent with such books as Robinson's "The Mind in the Making," Thompson's "Outline of Science," Wells' "Outline of History," and Edward W. Bok's "Americaniza- of Edward Bok," are of more lasting benefit.

Why Graduates Turn to Other Work

One of the causes for slow advancement in mining is that many of the graduates are not fitted for their work. Most graduates leave college loaded with facts, but enthused over no particular branch of mining, and four years behind the practical man in experience and in dollars-and-cents training. The particular graduate may not have acquired the spirit of hard work, and, on the contrary, the "college atmosphere" may have imparted mannerisms and an egotism that act as a distinct handicap. This is one of the problems for the college faculty. The mine operator appreciates it, but the faculty often neglects it, although spending much time debating over whether zoology or Spanish should be a required study and in disputes between department heads over their "pet" electives. The purpose of the mining school is not to cram facts into indifferent young men. It should attempt at least to enthuse the undergraduate to help himself to the knowledge so easily within his reach; it should sound him out and encourage him to make a specialty of the work he likes best, whether it be crystallography, metallography or surveying. The business and management side of mining should be brought to his attention and he should be shown that four years of easy living and pleasant associations will only make him an easy mark for the practical man, unless he succeeds in building character and personality.

The faculties seldom worry over the future of the older students who come to college after working in the mining camps, or over the young student who diligently applies himself to the goal he has set. The hardest problem is the average well-meaning young fellow who is content to drift along, enjoying college life while he goes. There would be fewer failures among mining graduates if the faculties paid more attention to the personal side of the students. The triflers would be weeded out early. The taxpayers are liberal, but they should not be called upon to contribute to forcing education upon unwilling students.

Upper-class men often assume an air of equality or even superiority with their professors. This may be shown by a slouchy carriage in the class room, by an air of indifference, or by a tendency to interrupt and argue with the professor. The professor often overlooks this, but when these men, as graduates, unconsciously fall into the same habits with foremen, superintendents, or managers, they make a poor impression, and in certain cases they are not given the opportunity to rectify their poor judgment. Men in authority tend to become dictatorial, and unconsciously expect considerable respect and attention from the younger men. Supeiors do not take kindly to suggestions from youngsters.

Previous experience in mining and metallurgy is valuable. However, most of the students come directly from the high school. It is not fair to these young men to ask them to spend four years on a course that may be for the most part imaginary to them. Each student should therefore be required to spend every summer vacation in practical work in some branch of mining. This has several advantages. It gives the young man the viewpoint of a wage earner with a knowledge of the wage earner's work, his surroundings and his ideas. It trains the eye and hand and engenders self-confidence and tact. It brings reality to the classroom, and is a stimulant to good work in the special courses of the last two years. The insistence on summer work would result in weeding out the unfit.

There are too many graduates in mining that for their own good should be in other lines of work. The universities and colleges, unwisely or not, strive for numbers as a mark of superiority. However, there is a reaction among thoughtful parents and students in favor of the smaller colleges, where the individual student will get more personal attention, and where a high standard of scholarship is required. The student who drops out of college after two or three years' work because of inability to meet the high scholarship requirements will make a better citizen, and often a better engineer, than if he were allowed to drift through the four years.

An English friend of mine once criticised the American collegiate system by stating that the colleges were so numerous and, because of state aid, the tuition and costs so low, that the resulting large number of graduates did not command the respect of the people as college graduates do in England. It is true that the professional ranks in America are made up in considerable part of the sons of skilled American workmen and farmers. With such a short gap between the skilled workman and the professional man it is to be expected that their social status and compensation should not be widely divergent.

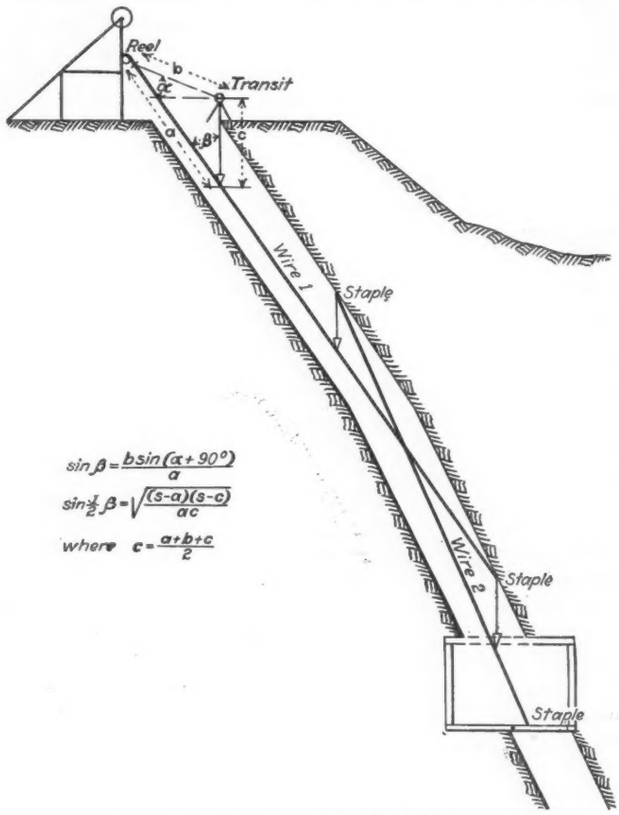
The professional man of today is beginning to resent and even at times to envy the compensation of the bricklayer, the plasterer, or the plumber. He has overestimated the commercial value of a college education. It no longer admits him into a charmed circle, but rather into a horizon where the competition is keener than among skilled workmen. There is no union to guarantee him equal pay with his fellows. His relative success depends upon how well he builds upon the groundwork laid in college.

Useful Operating Ideas

Surveying Steep Inclined Shafts Without an Auxiliary Telescope

BY EDWARD H. WISSER

It is occasionally desirable at a small property with limited engineering equipment to carry a transit survey of reasonable accuracy down a steeply inclined shaft. This problem arose at a gold property in the Southwest, developed through three inclined shafts, 4x7 ft. in the clear, about 250 ft. apart, and each about 200 ft. deep.



Sketch showing method of making survey

The dip of the vein and the inclination of the shafts averaged about 65 deg.; two of the shafts were connected by drifts. The transit in use was of the "light mountain" variety, and had no auxiliary telescope. A complete survey of the underground workings was wanted immediately, as no reliable mine maps were in existence.

The method adopted was that of stringing No. 24 (B. & S.) iron wire down the shafts, setting up at the collar over a point on the wire and transferring the azimuth from the surface traverse to the wire. Set-ups were made at the various levels, and the azimuth was transferred to the underground traverse stations. The inclination of the wire was obtained by two methods:

1. By measuring the vertical angle to a point on the wire, up the wire from the transit, and taping the distance along the wire from the point vertically beneath the transit to the point sighted, together with the distance from the horizontal axis of the transit to the point vertically beneath the transit (the "H. I."). This gave two sides and the angle opposite one of them of an oblique triangle.

2. By taping all three sides of the above triangle.

The inclination of the wire was measured in this manner at the collar and at each level, and the resulting values were averaged. The greatest single variation at any of the shafts was 12 minutes. (The vertical circle of the transit read to 5 minutes only.) The distance along the wire from the point at the collar to the points at the different levels was taped; spads were put in above these points by plumbing. A convenient reel was improvised for stretching the wire and placed above the collar, generally on the headframe. The wire was fastened to a staple near the bottom of each shaft, and the maximum safe tension applied.

The chief difficulty encountered was in setting up in such a manner as to get the greatest possible distance from the transit to the point on the wire used in measuring the vertical angle; in this case, it was just possible to get this point within the zone of focus of the transit and at the same time low enough down the wire so that the point could be sighted. The maximum angle that could be read was about 50 deg.

A further difficulty was met in the main working shaft, caused by the fact that the shaft steepened about 10 deg. about halfway down. It was not feasible to set up at this bend, because it was impossible, owing to the smallness of the shaft, to sight to a point down the wire from the transit. To overcome this, a second wire was strung down the steeper part of the shaft and fastened to a staple exactly above the first wire. This wire was lined up by moving the end, near the bottom of the shaft, until the wire came exactly beneath a plumb bob dropped from the end of the first wire, as shown in sketch. The azimuth was transferred and the two vertical angles were measured as described above; the distance from the point at the collar to the intersection of the two wires, and from the latter to the point at the bottom, was measured.

A closed traverse was run between the two connected shafts; the horizontal error of closure indicated an accuracy of 1:4000; the azimuth checked to 1 min. 30 sec.; elevations to 0.08 ft. This was sufficiently accurate for the purpose required.

How to Build a Crate

A crate does not appear a difficult thing to make, and its construction is often attempted by those whose knowledge of carpentering is limited to the use of hammer and saw. There is, however, a right and a wrong way to make one, and maximum rigidity with minimum lumber can be secured by following the suggestions of the Forest Products Laboratory. Fig. 1 and Fig. 3 illustrate incorrect methods; Fig. 2 is the proper way to do the job. Amateurs have been known to put a crate together in a much less efficient way even than is illustrated by Fig. 1.

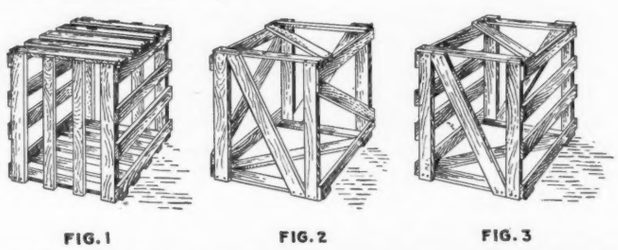


FIG. 1 FIG. 2 FIG. 3

Fig. 2 illustrates the proper method for building a crate

DISCUSSION

"Engineering and Mining Journal-Press" is not responsible for statements or opinions published under "Discussion." In many cases the views expressed are diametrically opposed to editorial policy and belief.

Aluminum for Copper

THE EDITOR:

Sir—Please refer to the article regarding copper entitled "French Market Is Quiet," which was published in the *Engineering and Mining Journal-Press* of Sept. 22, 1923.

In this article you state that the experiments conducted by the Southern Railways of France in connection with the use of aluminum instead of copper in the company's electrical equipment proved that aluminum could not be employed to the same advantage as copper.

As a leading company in the French aluminum industry, permit us to say that this information is quite inaccurate. In fact, the Southern Railways of France, after having purchased before the war a few hundred tons of aluminum wires, have just entered through us a new contract for the delivery of 2,000 tons more of this material to be used by them in their electrical equipment instead of copper.

This means, of course, that they were quite satisfied with the use of aluminum in their first experiments, otherwise they certainly would not have purchased a new large tonnage.

Deliveries against the last contract have begun, and we are allowed to say by the head office of the railways company that they are using aluminum to their entire satisfaction.

ALUMINIUM FRANÇAIS.

Paris, France.

Relation of Optimism to Copper Prices

THE EDITOR:

Sir—As you probably realize, there is a very general and genuine wailing in the West, because of the present low price of copper. Copper selling at 12½ or 13c. a pound is undoubtedly out of line with all other raw products. Copper bows, however, to the inexorable law of supply and demand, and this fixes its price, taken over a term of years. As modern business is conducted, consumers have to order and purchase their copper requirements from one month to a year or more in advance of the time that the manufactured article leaves their hands. Or, in other words, it is the duty of the consumer to estimate the future price (therefore production) of copper. From this estimate, he determines how large a stock he should carry. The present policy of "hand-to-mouth" buying of the metal indicates exactly what conclusion buyers have come to as to the probable quantity of copper to be produced in the near future. What other conclusion could copper consumers come to after reading in the reputable mining and technical magazines, and in the newspapers, such articles and interviews as in substance follow:

1. "The —— —— Consolidated Mining Co. is beginning to get in a much better class of labor. Production in September was —— million pounds of copper. The rock being mined at present is much richer than that mined in any previous year. Five of the twelve heads are in operation in the mill." (Leaving the uninitiated with the idea that as soon as labor is more plentiful production will be increased in the proportion of five to twelve.)

2. "The —— —— Copper Mining Co. is now employing 4,000 men and is very short of skilled miners. At capacity operation the company employs 7,500 men." (It is a well known fact that this mine could not use any more men than these present 4,000 on ore production if they were available, on account of their depleted ore reserves.)

3. "The new smelter of the —— Copper Co. is being rushed to completion. It will have a capacity of 60,000,000 lb. annually." (Inferring that there will presently be 60,000,000 lb. a year of new copper turned out, when as a matter of fact, this company has been producing at maximum capacity for some years and shipping its ore to another smelter.)

4. "The —— —— Copper Co. is producing 3,000,000 lb. a month, about 50 per cent of capacity." (In the case of this mine, a portion of this 3,000,000 lb. can only be profitably produced on a 16c. market, and there is very little likelihood that the present production can be maintained for more than a year longer, on account of depleted ore reserves.)

Not one of the above statements, all of which were written after interviews with western mine managers, contains an untruth, but they all contain half truths; they are errors of omission and not errors of commission.

Nothing is said about what production can be economically maintained during the next few years, but it is implied that the production could be increased immediately, if it was so desired, to a war-time output, stimulated by a price for copper which is not likely to be reached for a decade or two at any rate. Copper consumers use the peak war production as a yardstick to measure the possibilities of copper output. Copper producers know that they cannot begin to put out anywhere near as much copper as they did in 1917 and 1918, but will not admit it.

Not concerning ourselves with a demonstrated ample beneficiating capacity for copper ores, and assuming a satisfactory supply of labor, the United States production of copper for the next few years is limited entirely to the quantity of its developed ore reserves. Owing to a shortage of efficient labor since 1917, and to the low price of copper since 1920, the majority of the large copper mines of this country and northern Mexico are not in as good a physical condition as they were when the United States entered the World War. Development work and other necessary underground improvements have been neglected. Developed ore reserves have declined.

Optimistic statements on the part of well-known mine managers, while they make very good reading for local business men and property owners, and for the stockholders, are very misleading, and should be guarded against. Managers should insist that nothing gets into

print concerning their property except the entire truth.

Misleading, optimistic interviews and articles concerning the conditions at the country's largest copper mines have, to my mind, played no small part in depressing the price of copper to its present abnormally low figure. A COPPER PRODUCER.

Globe, Ariz.

Contact Between Prospector and Operator

THE EDITOR:

Sir—In the Oct. 6 issue of the *Journal-Press* there appeared in "Discussion" an article entitled "How to Sell Mining Property," which was written with the intention of impressing upon those about to attempt a sale the necessity of becoming a real estate broker in the State of California and incidently included a message of constructive suggestion for mining engineers between jobs.

Much to my surprise I find myself beset with new obstacles here in my mountain fastness, and the mail, instead of including the usual circulars of mining-equipment establishments which have not discovered that we succumbed to the high cost of producing the regal metal, now daily brings offers of various mineral deposits from real honest-to-God prospectors who say they cannot even on tip-toe reach high enough to whisper what they possess into the ears of those who are able to make their holdings commercial.

I find myself hemmed in on the north with a gold prospect; on the east I am asked to market forty million tons of limestone with adjacent shale, "only two miles off a main line transcontinental railway," suitable for cement manufacture, and to the south an exceedingly worthy knight of the pick tells me he has five feet of diatomaceous earth exposed for 700 ft. by being crosscut by a canyon.

To balance the above, a diligent fellow writes me: "My trouble has been to find a mining property worth taking. I have very good people in line, ample funds, and experienced operators who will take a chance on a prospect or a developed property or dredging ground."

The above, which I record couched in simple practical language, is at least sincere, and as you devote space to condemn such companies as the "Crown Sulpher and Products Company, Inc.," I respectfully ask that you allow this letter space, with the hope that these fellows through this publicity may receive inquiries for their products.

It was not my intention to become a dealer in mineral deposits, but if I can through your columns be of any material aid to the prospectors of this western country I should be glad to devote all the time I can spare to this kind of work. ROBERT J. BURGESS.

Yankee Hill, Calif.

Discovery of Rickardite

THE EDITOR:

Sir—I feel impelled to criticise T. A. Rickard's article on "Tellurides" published in the Dec. 2, 1922, issue of the *Journal-Press*. At the time that the article was published I felt that Mr. Rickard should have given credit to Dr. Loui Weiss as the discoverer of the telluride of copper, although it is not named for him. As Dr. Weiss was in California at the time I was unable to secure letters from Mr. Rickard to Dr. Weiss in which Mr. Rickard acknowledged Weiss' prior discovery of the mineral. On Dr. Weiss' return to Vulcan I was given the letters and made copies of them to send with my criticism. It is not my purpose to object to the name of the mineral. That is something that was established long ago and cannot be changed. I should be glad if you would publish this criticism in the "Discussion" columns of the *Engineering and Mining Journal-Press*.

Iola, Colo. WM. P. CRAWFORD.

The facts of the foregoing case are stated correctly in the correspondence that Mr. Crawford has submitted. Yes, I had forgotten that Dr. Weiss had suggested the probability that the red mineral was the telluride of copper. As the letters show, I made the tests for the two metals as soon as a specimen was given to me on the occasion of my visit to the Good Hope mine, and subsequently handed other specimens to Professor Penfield at Yale. Dr. Weiss is entitled to the credit of "discovery." The facts are stated in my letter to Philip Argall under date of March 17, 1903, from which I quote:

"For the last ten years I have been collecting tellurides, my connection with mines in Boulder County, Cripple Creek, and the La Plata district in Colorado, as well as a journey to Kalgoorlie, Western Australia, having afforded me the chance of securing some fine specimens. Many of my specimens have been examined by Mr. Richard Pearce at Denver and by Professor Penfield and Mr. Ford at Yale. In the course of tests made by the two latter, they thought they detected copper in a specimen from Kalgoorlie. This fact led me to hope that the telluride of copper, which was notably absent from the list of known tellurides, might be found. Mr. Heimberger, of the Vulcan mine, adjacent to the Good Hope, gave me some specimens of native tellurium in 1899. In 1901, Dr. Weiss also was kind enough to do so, and I got into communication with him. Early in 1902 he sent me some specimens containing a dark-red mineral which he said he thought contained copper and tellurium. They remained in my office until last September, when, visiting the Good Hope mine in the course of a cross-country ride, I was shown by Dr. Weiss the occurrence of this mineral in the mine. This made the matter very interesting, for the vein is of an unusual type, and on my return to Denver I packed up the pieces of ore and took them with me, on coming to New York in October. In the meantime at the end of September, Mr. George Bancroft, on my speaking to him about the combination of copper and tellurium, had taken me to Mr. Sanford's assay office. Mr. Sanford was busy at the time and simply told me that he had made some tests and had found copper in association with tellurium. In October I went to Yale and showed my specimens to Professor Penfield, spending an afternoon with him in his laboratory while tests were made. These established the existence of copper and tellurium, so, upon my return to New York, I forwarded to him and Mr. Ford all the pieces of ore in my possession. I also wrote to Dr. Weiss and he sent more material for this investigation, of which I fully informed him, appreciating his interest in the matter. Mr. Ford made complete analyses, determined the fact that the mineral was a new species, and Professor Penfield wrote asking if he might give it my name. In according me this courtesy, Messrs. Penfield and Ford were doubtless influenced by the incident of knowing me and also by my keen interest in the telluride group of minerals, of

which they had been made aware for several years by the receipt of specimens which I had sent them for analysis. Dr. Weiss was the first to suspect the occurrence of a telluride of copper; evidently Mr. Sanford made a similar inference, but Messrs. Penfield and Ford were the only ones who proved it by complete analyses. It was merely my good fortune to further the investigation by my interest in these minerals, of which I possess a fine collection." T. A. RICKARD.

San Francisco, Calif.

As to the Filling of Veins

THE EDITOR:

Sir—The following matter, written in 1916, may still be of some interest to others, in connection with the article on "The Filling of Fissure Veins," by J. E. Spurr, in your issue of Aug. 25:

An article by A. M. Balfour, appearing in the *Mining and Scientific Press*, issue of May 20, 1916, entitled "Some Peculiar Ore Deposits," recording interesting occurrences observed, and touching upon the formation of veins and their filling by magmatic injection, is of marked interest. Thirty-five years' study in the field has led me to a strong belief in the leading part played by magmatic injection in primary ore deposits, and it may be that some impressions of my own will be suggestive to other observers.

It is difficult intelligibly to convey the idea of a generalization regarding a matter subject to infinite variation in controlling conditions, with equal variety of exhibited result; especially so where the conception covers a wide ground of transference of matter in which economically valuable ore deposits are minor incidents, and I fear that the present writing is subject to the misapplication to which a text without context is liable.

An unscientific style of dogmatic assertion, assumed for the sake of clarity and brevity, may be relieved by use of the words think, opine, presume, assume, take for granted, suppose, theorize, surmise, conceive, imagine, speculate, conjecture, and wis — interpolated as the reader sees fit.

Ores are mineral elements and compounds especially desired by man: otherwise they are simply rocks.

Magmas vary in composition. They, and extrusions from them, and the rocks through which such extrusions pass, are subject to differing conditions as to consistency, temperature, pressure, chemism, and duration and succession of action.

An extrusion from magma may be a part of the undifferentiated mass, a differentiation or segregation thereof, a residual solution or other emission therefrom, or a combination of these things. Under conditions of extrusion the normal direction of the extruded matter is upward.

When stresses in a superincumbent retaining material occur from any cause, and fracturing and fissuring result, such fissures may be filled *as they open* by injection of a magmatic extrusion under pressure; or by injection of mobile matter expressed from a zone or body of rock *not* a magma.

As pointing out a conception having application to the practical study of ore occurrence and the filling of veins, let us assume that a crystallizing magma, contracting and under stress from above or through lateral compression, expresses a mobile matter or solution containing silica and metals, itself under the pressure affecting the magma.

Any opening which affords access to such matter or solution will be promptly filled by the same, and the infinite variety of conditions in amount, composition, liquidity, chemism, motion, temperature, pressure, permeability, and character of inclosing material or walls, controls the infinite variety of results in deposits, impregnations, and infiltrations in and adjoining such bodies. And such results may well be considered as primary deposits.

That all veins are thus filled and all ore deposits are thus accounted for is by no means asserted, but perhaps an understanding of the conception may afford suggestive aid in a study of vein fillings and oreshoots where the maintenance of an open channel and circulation of solutions through long periods of time seem hardly tenable.

Solution and replacement of wall rock may attend or follow.

Application to matter not classed as ore, and to forms of deposit not classed as veins, is evident.

Pasadena, Calif. T. A. PERKINS.

THE EDITOR:

Sir—In the Oct. 13, 1923, issue of the *Journal-Press*, a contributor, Jacob W. Young, refers to an article by J. E. Spurr appearing in the Aug. 25, 1923, issue, entitled "The Filling of Fissure Veins." Apparently, the viscid condition of the injection is considered by Mr. Spurr sufficiently proven, because "the edges of the blocks are sharp." Why shouldn't they show "sharp edges"? It is not necessary for the inclosed fragments to show edges other than sharp, when they are found inclosed in a vein filling that was formed by replacement. As quoted by Mr. Spurr, the authors of the Bulletin above referred to state, that "The solutions which cemented these materials apparently had little power to dissolve the rhyolite."

In any given case, if the injection causing the replacement was cut off at its source, before "all" the broken material was replaced, it would also cause sharp edges. It is to be expected that injections, whether liquid, fluid, or viscous, will obey the natural law of least resistance, and in diffusing through lines of fractures, their physical and chemical energy ought to be potent on "all" sides of the inclosed fragment. If they are equally potent, then the facets of the inclosed fragment would be replaced at an equal rate, and—unless the fragment was completely replaced—the edges, and their relation to the original facets, would be preserved.

The foregoing must not be inferred as denying the existence, ejection or injection of "viscid" magmas. In view of the recorded phenomena in Mexico and California, such a denial would be absurd. I do submit, though, that the presence of "angular" fragments in a vein filling is not proof positive that the injection was of any given physical condition. It may have been a fluid, a liquid, a viscid body, or even gaseous, or a combination of all these states.

I can admit no tenable postulate why veins may not have their inception on, and ores cannot be deposited at, the surface—of the present, or of the past—as well as in great depths. LOUIS H. SMITH.

Chichagof, Alaska.

Recent Technical Publications

Reviews, Abstracts, and References

Silver, Its History and Romance. By Benjamin White. Revised Edition. Price 21s. (22s. 1d. in America). Obtainable from Messrs. Waterlow & Sons, Great Winchester St., London Wall, London E.C.2, England.

Two chapters have been added to this work, bringing it up to date. Mr. White is considered an authority on the subject covered, and the book has been favorably received by the press and by the industries engaged in the handling of the metal. It serves well, also, as a textbook on silver.

Tunneling. "Engineering Features of the Moffat Tunnel" was the subject of and after-dinner talk by D. W. Brunton at a dinner given by the Colorado Scientific Society in Denver recently. The speech has been printed in the Proceedings of the Society, Vol. II, pp. 381-398. The history of the project and a description of the methods employed and the work done to date is given by Mr. Brunton.

Gypsum—The report of the Imperial Mineral Resources Bureau on gypsum for the war period gives a comprehensive account of this mineral product, including figures showing production, imports and exports in the British Empire and in other countries.

Petroleum—One of the latest publications of the Imperial Mineral Resources Bureau is entitled "Petroleum and Allied Products." Statistics of the industry in the British Empire and in other countries are given for 1919-1921.

Limestone—Both *Iron Age* and *Iron Trade Review*, in their respective issues for Sept. 20 last, published an article describing the new plant additions of the Marble Cliff Quarries Co., near Columbus, Ohio, which produces limestone for road building, construction, and fluxing purposes.

Dust Underground—Sir R. N. Kotze is the author of an article entitled "A New Method of Dust Determination," published in the July, 1923, issue of the *Journal* of the Chemical, Metallurgical and Mining Society of South Africa, in which he discusses experiments made with the Kotze konimeter.

Ballarat Gold Field—Much information about the Ballarat gold field—its history, topography, physiography and mining operations there—is given in Memoir No. 14 of the Geological Survey of Victoria. Accompanying it is a set of thirty-two maps.

Antimony and Lead—*The Metal Industry* for October contains an article entitled "The Production of Antimony and Lead," which is the report of a visit to the works of Cookson & Co., Newcastle-on-Tyne, England.

Gold and Silver—Another of the recent bulletins on the mineral industry of the British Empire and other countries is entitled "Gold," containing statistics for 1919 to 1921. A similar bulletin is entitled "Silver."

Tourmaline-Albite—A unique specimen of tourmaline-albite rock, found at Enoggera, near Brisbane, Queensland, was discussed recently by W. H. Bryan before the Royal Society of Queensland. A digest of this paper is given in the *Queensland Government Mining Journal* for Sept. 15, 1923.

New Patents

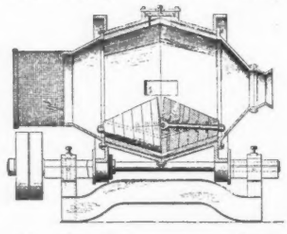
Drill Bit—No. 1,463,848. Aug. 7, 1923. E. W. Shimin, Thermopolis, Wyo. A drill bit with a cruciform head and

beveled wings as shown in the illustration.

Tin Refining—No. 1,466,126. Aug. 28, 1923. Colin G. Fink, Yonkers, N. Y., assignor to Guggenheim Bros., New York City. The patent covers the electro-deposition of tin from an electrolyte containing a preponderating concentration of sulphate ions compared to other anions therein, and a concentration of ions of a metal more electropositive than tin preponderating with respect to other actions therein.

Roasting Furnace—No. 1,466,382. Aug. 28, 1923. R. D. Pike, San Francisco. A multiple-earth roasting furnace similar in general features to the MacDougall, with provision for removing material from any hearth, for adding fuel or heat to the hearths, and special means for handling the cooling air or water.

Crusher—No. 1,463,921. Aug. 7, 1923. O. J. Moussette, Richmond Hill, N. Y.



A crusher having a tapered drum on which rollers revolve as shown in the accompanying illustration.

Electrolytic Zinc and Iron—No. 1,466,793. Sept. 4, 1923. F. A. Eustis, Milton, Mass., and Donald Belcher, Boston, assignors of one-half to Eustis and one-half to C. P. Perin, New York City. Ores containing iron and zinc sulphides are dissolved and the solution subjected to electrolysis for the recovery of a cathode deposit of mixed iron and zinc. The zinc is then removed from the deposited metals by volatilization in an electric furnace, pure iron remaining.

Grinding Mill—No. 1,466,433. Aug. 28, 1923. W. A. Gibson and C. E. Needham, Allentown, Pa., assignors to Bradley Pulverizer Co., Boston. A new design of a swing-hammer pulverizer.

Chloridizing—No. 1,467,037. J. H. Hirt, El Paso, Tex., assignor to Alvarado Mining & Milling Co., New York City. A body of ore is fed to a chloridizing chamber at a rate which ensures the presence of a layer of cooler ore over the reaction zone, thus preventing the escape of volatile metal chlorides by condensing the latter in the layer of cooler ore.

Zirconium Recovery—No. 1,467,275. Sept. 4, 1923. Joseph Koerner, Coburg, Germany. Zirconium oxide is recovered from zirconium ores by fusing the ore with a fluoride of silicon.

Concentrating Oxidized Ore—No. 1,467,354. Sept. 11, 1923. N. C. Christensen, Salt Lake City, Utah. Oxidized ores are ground and mixed with water, being kept free from electrolytes which inhibit the selective formation of oil-mineral floccules containing non-siliceous minerals. An oil is then added, containing an organic acid, the mixture agitated, and the floccules containing the oxidized minerals, but not containing the siliceous minerals, removed.

Rock Drill—No. 1,467,479. Joseph Henritzi, Spokane, Wash. A rotary rock drill comprising two sets of cone bits, the lower set drilling a small hole, which is enlarged by the upper set.

Leaching Ore—No. 1,467,516. Sept. 11, 1923. U. C. Tainton, Kellogg, Idaho. A roasted complex ore is separated into two portions, one containing compounds difficult to dissolve and the other the more easily soluble compounds. A strong acid solution is then used on the first portion, the other portion being treated with the acid after its strength has been suitably reduced.

Smelting Manganese Ore—No. 1,467,797. B. G. Klugh, Anniston, Ala., assignor to Southern Manganese Corporation, Anniston, Ala. Crushed manganese carbonate ore is mixed with carbonaceous coking material and the mixture subjected to a low red heat. Thereby the carbon dioxide is expelled from the ore, the volatile constituents from the coking material, and a homogeneous mass suitable for smelting is obtained.

Mechanical Shovel—Reissue No. 15,685. Sept. 18, 1923. Samuel Hoar, Virginia, Minn., assignor to Rex Loading & Engineering Co., Duluth, Minn. A mechanical shovel for use in mining and similar work.

Table Head Motion—No. 1,468,575. Sept. 18, 1923. C. F. Reiff, Fort Wayne, Ind., assignor to Deister Concentrator Co. Design for an inclosed head motion for a concentrating table.

Hydrometallurgy of Copper—No. 1,468,806. W. E. Greenawalt, Denver, Colo. Pyritic copper ore or concentrate is roasted until most of the sulphur is liberated and most of the iron is converted to oxide. Small quantities of pyritic ore are then added to the hot calcine and the roasting is completed, after which the material is leached.

Societies, Addresses, and Reports

California Dredge Men Meet

Machinery Companies Act as Hosts—Work of Making Buckets Inspected

THE California Gold Dredge Operators' Association held a meeting in San Francisco on Nov. 23, 1923. The hosts of the occasion were the American Manganese Steel Co. and the Taylor Wharton Iron & Steel Co. Luncheon was served at the former company's plant and the afternoon was spent in the company's steel foundry, where the work of making dredge buckets and bucket lips was inspected. In the evening, after dinner at which the Taylor Wharton Iron & Steel Co., represented by G. V. Wood, was host, Mr. Wood presented a paper, illustrated by excellent lantern slides and describing the operations of the Taylor Wharton company at High Bridge, N. Y. Mr. Wood also displayed a moving picture showing the use of the Linn tractor in hauling materials for construction under abnormally bad road conditions.

The following members and guests were present:

George J. Carr, M. & H. Piston Ring Co.; A. H. Gregory, N. Y. Belting & Packing Co.; Charles W. Gardiner, Yuba Consolidated Gold Fields; John Henry Nash; C. H. Fry, mining engineer; Robert I. Kerr, Cal. M. M. P. Association; E. W. Stebbins, El Oro Dredging Co.; G. L. Hurst, mechanical engineer; H. K. McJunkins, Yuba Manufacturing Co.; W. C. Hammon and W. H. Gardner, Hammon Engineering Co.; C. V. Wood, Taylor-Wharton Iron & Steel Co.; L. D. Hopfield; C. H. Thurman, Natomas Co. of California; C. M. Romanowitz, Yuba Manufacturing Co.; D. H. Young, American Manganese Steel Co.; L. N. Parks, El Oro Dredging Co.; Victor H. Doyle, Hammon Engineering Co.; P. R. Parker, Atkins & Parker, engineers; A. R. Dole, Yuba Consolidated Gold Fields; George E. Sibbett, Columbia Steel Co.; L. A. Decoto, Linscott Drilling Co.; G. V. Smith, Shasta Dredging Co.; H. C. Perring, Pacific Gold Dredging Co.; George B. Dodge and W. Gregg Hanson, American Rubber Manufacturing Co.; Thomas D. Harris, Marysville G. D. Co.; A. J. White, J. W. Frank, Co-operative Electric Co.; H. E. Chesebro, Trinity Dredging Co.; C. W. W. Whitney, Bucyrus Co.; G. H. Edmonds, Conroy Placer Mining Co.; R. P. Hasmauer, William W. Avery, Gerald H. Hutton and Robert E. Cranston, Metals Exploration Co.; B. G. Smith, Natomas Co.; A. J. McCasty, Yuba Consolidated Gold Fields; Corey C. Brayton, American Manganese Steel Co.; Peter C. Jurs, Bethlehem Steel Corporation; Arthur S. Brown, Charles C. Sunderland and F. W. Hammond, Roeblings; Leigh S. Jones and R. K. Estep, Natomas Co.; W. B. Macaulay, Yuba Manufacturing Co.; W. Heinemann, Columbia Steel Corporation; Ed. S. McDowell and G. C. Aaronson, Yuba Consolidated Gold Fields; C. F. Fetherston, American Manganese Steel Co.; P. C. Knapp, Natomas Company of California; and George J. Young, of the *Engineering and Mining Journal-Press*.

Appoint Exchange Professor of Engineering to France

The appointment of Dr. Douglas W. Johnson as exchange engineering professor to France has been announced at Columbia University. Dr. Johnson, the third American to receive this honor, has been professor of physiography at Columbia since 1901, and is internationally known as educator, author, and scientist.

Serving for the next academic year, he will represent seven institutions on the Atlantic Coast with which the National Department of Public Instruction in France has established exchange relations in engineering and applied science. These include Cornell, Harvard, Johns Hopkins, Massachusetts Institute of Technology, University of Pennsylvania, Yale, and Columbia.

France's representative to this country is yet to be officially named. Last year the envoy was Dr. E. de Margerie, director of the Geological Survey of Alsace and Lorraine and professor in the University of Strasbourg. He spent a month lecturing at each of the designated schools, and his successor will follow the same plan, beginning probably at Columbia.

C.M.I.A. to Meet Dec. 19-21 in Pittsburgh

The thirty-seventh annual meeting of the Coal Mining Institute of America will be held Dec. 19, 20, and 21 at the Chamber of Commerce Auditorium, Pittsburgh, Pa. The program is naturally devoted principally to coal-mining topics. One of the questions for discussion included in it is: "Does dynamite exert a greater force downward or does it exert the same force equally in all directions?" A motion picture entitled "The Story of Dynamite" will be shown.

Electrochemists Set Date for Next Meeting

The next meeting of the American Electrochemical Society will take place April 24, 25, and 26, 1924, in Philadelphia, with headquarters at the Bellevue-Stratford. One of the principal attractions of the technical program will be a symposium on "Recent Progress in Electrodeposition." S. Skowronski, research chemist, Raritan Copper Works, Perth Amboy, N. J., will act as chairman.

Meeting of Colorado Mining Men Set for January

Silver Representatives Will Speak on Plans for Aiding Industry—Liquid Oxygen to Be Demonstrated

The eleventh annual meeting of the Colorado Metal Mining Association, and the sixth annual meeting of the Colorado Chapter of the American Mining Congress will be held in joint session at the Albany Hotel, in Denver, Jan. 23 and 24, 1924. Among the features of the program will be an address by Fred Carroll, manager of the Atlas Mining & Milling Co., who will speak on the proposed Silver Export Association. Jesse F. McDonald, manager of the Down Town Mines Co., of Leadville, and Colorado director of the American Silver Produecrs' Association, will outline the plans of that organization, and explain how it would function with an export association.

A representative of the U. S. Bureau of Mines will talk on the subject of "Liquid Oxygen as an Explosive," and a demonstration of its use will be made on the grounds of the Denver Rock Drill Co. A report of progress made by the U. S. Geological Survey on the topographical and geological survey of Colorado during the past year will be submitted, and the work for 1924 will be outlined.

A representative of the Union Oil Co. of California, which has invested approximately $1,000,000 in shale lands in Colorado, and which opened up the big gasser in the Fort Collins district, will speak on "Colorado Oil Shale as a Source of Future Oil Supply." Other subjects will be "Railroads and Mines," "Legislation and the Mining Industry," "Colorado Smelting Conditions," "Co-operation of State Agencies to Assist Prospector and Small Mine Owner," and "Tariff Laws Affecting Colorado Mines."

Woman's Auxiliary of A.I.M.E. Raising Funds

The New York Section of the Woman's Auxiliary of the A.I.M.E. is giving three subscription dances, to which all members of the various engineering societies are welcome as well as students in the engineering courses and in the School of Mines. The first dance will be held this evening, Dec. 8, at the Engineering Building, New York, 29 West 39th St. There will be refreshments and cards for those who do not dance. The second dance will be held Jan. 19; the third April 26. Tickets may be had on the ninth floor of the Engineering Building.

These dances are planned for the purpose of raising money with which to defray the expenses of the philanthropic work of the various committees of the Woman's Auxiliary, notably the "emergency chest" and the hand-made Braille books for the blind. There are no adequate funds in this country for press-made books for the adult blind, and the Auxiliary has organized a unit to make such books by hand.

MEN YOU SHOULD KNOW ABOUT

Robert E. Cranston is in San Francisco.

Charles E. Rogers will be in New York until Dec. 15.

Seeley W. Mudd is expected in Los Angeles on his return from New York.

Charles D. Kaeding, president of the Candelaria Mines Co., has been in Reno from San Francisco.

W. L. Honnold, now living in Los Angeles, is recovering from a serious operation for appendicitis.

Djevad Eyoub is in Mexico making an examination of the probable oil fields of the Tamaulipas district.

William Kelly has removed from Vulcan, Mich., to Iron Mountain, in the same state.

Nathaniel H. Burley, who has been making examinations in Arizona, has returned to his Los Angeles headquarters.

Mark Evans has left the Yukon Gold Co. and is now with the Treadwell Yukon Mining Co., Ltd., Keno City, Y. T., Canada.

Pope Yeatman and **Edwin S. Berry,** consulting engineers of New York, were recent visitors to the plant of the Mesabi Iron Co., at Babbitt, Minn.

Charles A. Chase has just returned from a three months' trip into Mexico on examination work. His address now is 824 Cooper Building, Denver, Colo.

R. E. Collom, consulting petroleum engineer, is now associated with **Carl H. Beal,** consulting geologist. Their offices are in the Crocker Building, San Francisco.

R. M. Henderson, manager of the Wellington Mines Co. at Breckenridge, Colo., is in Reno, Nev., in connection with property holdings of his company in that state.

George T. Coffey and **Frank C. Powell,** of the Yukon Gold Co., left Dawson, Y. T., recently for Seattle. Mr. Powell is en route to the Federated Malay States.

Herbert G. Officer sailed for Chile and the Argentine on Nov. 29, on the steamship "Santa Luisa." He will be engaged in South America several months, in the examination of oil and mining properties.

Ralph Baverstock, of Baverstock & Payne, Los Angeles, has just returned from an examination trip along the Colorado River, in California, which covered the Rincon and Copper Basin mines.

H. C. Dudley, vice-president of the Ahumada Lead Co., has returned to his home in Duluth after a business trip in the West and Southwest, including a trip to the Ahumada properties in Mexico.

A. G. Mackenzie, secretary of the Utah Chapter of the American Mining Congress, was in Denver on Nov. 30, consulting with the Colorado organization regarding matters affecting the industry.

J. P. Bickell, president of the McIntyre Porcupine mines, has returned from England, where, it is reported, he has been negotiating for the sale by the company of the Blue Diamond coal mine, in Alberta.

F. A. Warren, formerly metallurgist and smelter superintendent of the Kingdon Mining, Smelting & Manufacturing Co., Ltd., with head offices in Montreal, has been appointed general superintendent of the Illinois Zinc Co., Peru, Ill.

Humphrey M. Morgans

Humphrey M. Morgans, of London, has been elected president of the Institution of Mining and Metallurgy.

H. A. C. Jenison, who has served for several years as the U. S. Geological Survey's specialist, has resigned that position and has accepted an appointment with the Senate Gold and Silver Inquiry Commission.

Frank H. Ahier, mining engineer, has resigned from the Shropshire Mines, Ltd., and has been appointed resident mineral engineer to the Lord Leconfield Estates, in Cumberland, his present address being North Lodge, Cockermouth, Cumberland, England.

Dr. H. M. Ami, of the Canadian Geological Survey, has returned from France and northern Italy, where he has been for some time collecting geological specimens for Canadian museums and universities. He also delivered a number of lectures in connection with the Canadian Exhibition train.

The University of Wisconsin, which each year invites some outside man for a series of three lectures on a special topic of interest, has this year invited **J. E. Spurr** to lecture on ore magmas, or in general on the origin of ores. Mr. Spurr has also been invited by Johns Hopkins University to deliver a special series of five lectures on the same subject.

Fred Carroll, manager of the Atlas Mining & Milling Co., at Ouray, Colo., director of the proposed Silver Export Association, returned from the New York meeting of the association on Nov. 25. Mr. Carroll also visited Washington, and reports a very friendly attitude of the Administration toward any reasonable measures that will be helpful to the mining industry.

S. J. Schofield, professor of geology at the University of British Columbia, has gone to Hongkong to lay the foundation for a geological survey of the colony. He has a year's leave of absence from the university. Dr. Schofield has contributed lavishly to the publications of the Canadian Geological Survey, particularly on the genesis of the ore deposits of British Columbia.

Charles T. Kirk, of Tulsa, has been inspecting silver prospects in southern Mexico, where he finds the industry much brighter since recognition on the part of the United States. Mr. Kirk reports that other nations are sending in representatives who are ready to take advantage of Mexico's mineral and water-power resources and to market machinery in competition with manufacturers in the United States.

Frank H. Probert, dean of the College of Mining of the University of California, who in 1920 was appointed a committee of one to investigate the possibilities of building a stadium for the university, recently presided over the dedicatory exercises of the California Memorial Stadium, at Berkeley, the construction of which was due in conspicuous measure to Dean Probert's zeal and executive ability. The stadium seats 73,000.

Dr. Thomas T. Read, supervising mining engineer of the U. S. Bureau of Mines, Department of the Interior, has been awarded a gold medal and a commemoration diploma by the Government of Brazil. Dr. Read was the representative of the Department of the Interior with the United States Commission to the celebration of the one hundredth anniversary of the independence of Brazil at Rio de Janeiro last year and was also the special delegate of the American Institute of Mining and Metallurgical Engineers and the Federated American Engineering Societies to the International Engineering Congress held in connection with the celebration.

OBITUARY

A. S. Cooper, at one time state mineralogist of California, recently died in Los Angeles, Calif. Mr. Cooper was engaged in petroleum geology up to the time of his death.

Thomas Morgan died at Montreal on Nov. 28 at the age of seventy-four. He was a Scotchman by birth and was graduated in chemistry at London University in 1881. Mr. Morgan was the first manufacturer of portland cement in Canada at a plant established at Longue Pointe, Que., in the early 90's. He was the author of several works on chemical research.

THE MINING NEWS

The Mining News of ENGINEERING AND MINING JOURNAL-PRESS is obtained exclusively from its own staff and correspondents, both in the United States and in foreign fields. If, under exceptional conditions, material emanating from other sources is published, due acknowledgment and credit will be accorded.

Summary of the Week

THE LABOR SITUATION in the Michigan copper country is better than at any time during the last three years. To conform with the other operators, the Quincy company has restored the wage scale that it reduced Nov. 1.

The U. V. X. mine, at Jerome, Ariz., is producing 500 tons of ore per day, from which is made 3,000,000 lb. of copper per month.

The Park-Utah Mining Co., having completed the installation of new plant, will increase smelter shipments materially.

The finding of rich ore 3,600 ft. below the surface at the Bunker Hill mine, at Kellogg, Idaho, assures many more years of profitable operation.

A new wet process for treating asbestos ore may revolutionize the industry in Quebec.

Stripping for a new iron mine near Canisteo, on the Mesabi range, has been commenced by the Oliver Iron Mining Co.

The Magma Copper Co. will discontinue shipments to the Hayden smelter and stock ore and concentrate for its own smelter after Jan. 1.

The Candelaria Mines Co. has suspended operations at its silver property in Nevada.

Ore on the 4,200 level of the Kennedy mine, at Jackson, Calif., has been crosscut and drifted on for 100 ft.

Both the Bureau of Mines and the Geological Survey get increased appropriations in the tentative budget submitted by the President.

The Consolidated M. & S. Co. is treating 1,000 tons of Rossland ore at the Trail smelter. The high price of coke has made pyritic smelting uneconomical.

New Iron Mine Near Canisteo Will Be Opened

Oliver Company Will Strip During Winter with Three Steam Shovels—Ore Will Be Washed at Trout Lake

The Oliver Iron Mining Co. will at once start stripping operations with at least three railroad type steam shovels on a new mine, the Lewis, in the Canisteo district on the Mesabi range in Minnesota. The work will continue through the winter. The new mine will include four forty-acre tracts and will extend from what is now known as the Walker pit through to the Danube mine, northeast of Bovey.

The organization heretofore used in the Canisteo mine will be shifted to the new property and will be under the direction of H. F. Downing, superintendent of the Canisteo.

The announcement of the new property is especially welcome in view of the uncertainty attending the operations at the Canisteo mine. The opening up of the Lewis will take up the slack caused by the decreased operations at the Canisteo.

The new property has an orebody consisting of about 8,000,000 tons of iron ore, according to the last report of the Minnesota State Tax Commission. Practically all of this ore is to be concentrated at the Trout Lake washing plant.

It is stated that between two and three years will be expended in stripping operations before any ore is mined or shipped. From this it will be seen that the operations are to be large and extensive and the tonnage of iron ore on the properties will mean that it will be an active mine for many years to come.

Gratiot No. 2 Crushers Installed; Production to Start

It is expected that production at Gratiot No. 2 shaft of Seneca, in the Michigan copper district, will be started about Dec. 15. The rock crushers have been installed in the new rockhouse, and the bins are now receiving attention. In Seneca shaft, stoping is under way in the second, fourth and fifth levels. Both compartments of the shaft are now hoisting and tonnage is gradually growing.

Drifting is proceeding on the third and seventh levels, north. The third is now 3,730 ft. in length and but a short distance from the point under Gratiot No. 2 shaft, where a raise will be started to connect with the shaft. This will make available a large area of copper ground as well as provide ventilation. Preparations are under way to sink from the seventh to the eighth level. Sinking of Gratiot No. 2 is proceeding below the 17th level. Stoping is being done in the 13th level south drift. The shaft, now 2,350 ft. deep, has 850 ft. to go to make connection with Seneca No. 1.

U. V. X. Output 500 Tons of 13 Per Cent Ore Daily

Develops Jerome Verde Ground—Did Not Cut Wages With Other Companies on Nov. 1

The United Verde Extension Mining Co., at Jerome, Ariz., is conducting important exploration work on the west side of the main fault and it is reported that some promising oxidized porphyry has been encountered. Production has been maintained at about 3,500,000 lb. per month, this being considered the normal rate of output. This means a daily production from the mine of only 500 tons of ore per day on account of the high grade of the orebody which is being mined.

A regular amount of development work is also being carried on in the Jerome Verde mine by the United Verde Extension. The Jerome Verde claims adjoin the Extension property and the mine affords ready access for deep exploration. No important discovery has been announced as a consequence of this development work, but it is considered to be a likely prospect, as there are numerous outcrops on the surface of the Jerome Verde holdings, some of which have been productive.

The United Verde Extension Co. is probably the only one of the major producing companies in Arizona that did not cut wages at the time of the general decrease on Nov. 1. The $5.95 scale for miners has been retained.

Ottawa Mint Gives Low Bullion Returns, Charged

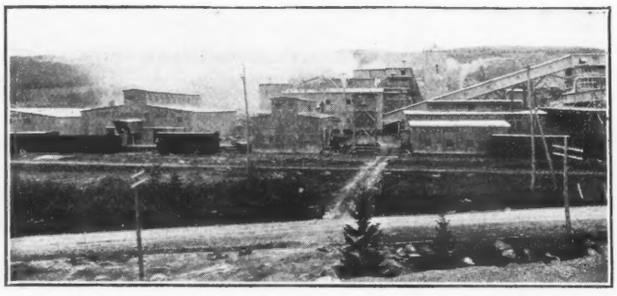
SEVERAL of the northern Ontario gold mines complain of a deficiency in payment received from the Mint at Ottawa for their bullion. Gold bricks are assayed in the refinery at the mines, and it has been found that there is a substantial difference between the values shown by these tests and the returns from the Mint. Instances are given where a difference of $300 occurred on bricks valued at about $30,000. An effort is being made to ascertain the cause of these discrepancies.

New Process May Revolutionize Asbestos Milling

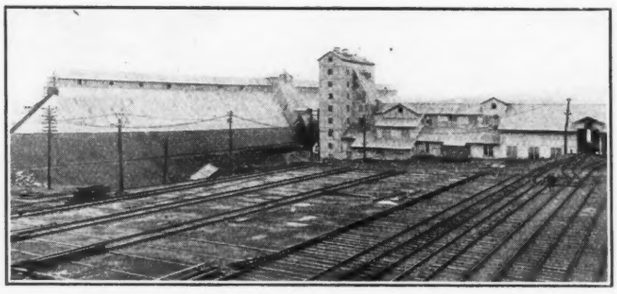
Selective Treatment, Ltd., Plans Commercial-size Plant at Thetford Mines—Feature Is Wet Method of Crushing Rock and Liberating Fiber

THE recovery of asbestos fibre from its ore by a wet process instead of by the hitherto universally used dry treatment is the purpose of a new 25-ton-per-hour plant that is to be built at Thetford Mines, Quebec, by a corporation known as Selective Treatment, Ltd. If the claims of the company, based on work done during the past year in the specially built experimental plant, shown in the accompanying illustration, are realized, this new process promises to revolutionize the asbestos industry. The process was developed by Sam H. Dolbear, president of the company, who began research in 1921. The testing plant at Thetford Mines was erected early in 1923 near the Bennett-Martin Asbestos & Chrome Co.'s mill. Thetford Mines is the center of the world's principal asbestos-mining industry and has the largest mines and mills in existence.

A peculiar feature of the asbestos industry is that there has been devised no method of "assaying" asbestos ore. In the first place, there is no known method of recovering all of the asbestos present in the rock, due to the fact that if the rock is pulverized sufficiently to release it, a part of the fibre is also reduced to dust. Another difficulty is due to the fact that long fibres have a higher value than short fibres; therefore, to "assay" the ore, it it necessary to know the length of all of the fibre as it occurs in the ore. No matter how carefully a small sample may be handled, there is apt to be some breakage of fibre, which would of course tend to reduce the value of the sample. The problem for operators, therefore, re-



B. C. asbestos mill at Black Lake, near Thetford Mines



Crushing, drying and storage plants at Kings mill, Thetford

"Continuity of Ore at Depth Established," Says Easton

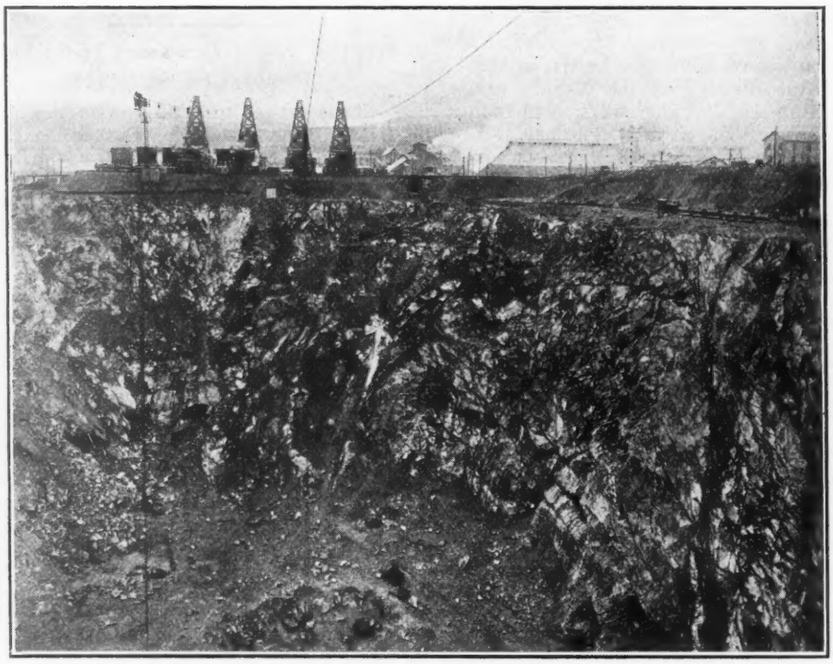
Bunker Hill Manager Reports Good Ore 3,600 Ft. Below Surface—Deepest in Coeur d'Alene

An important discovery of good ore has recently been made in the lower workings of the Bunker Hill & Sullivan mine, at Kellogg, Idaho, according to Stanly Easton, manager. The showing is on the seventeenth level, the deepest in the Coeur d'Alene. It is 3,600 ft. below surface. Mr. Easton says:

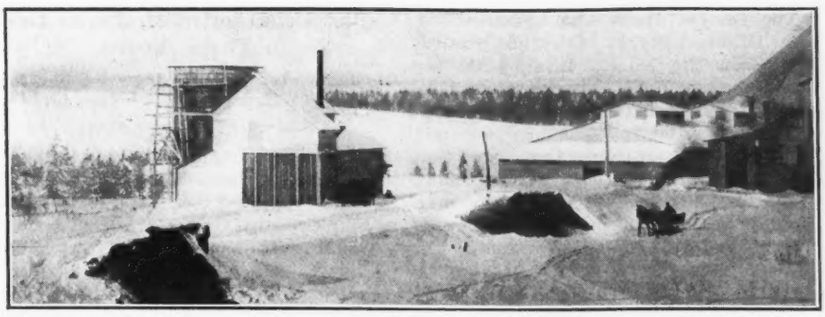
"As yet we don't know the magnitude of the discovery, but the grade and character of the ore are such that we feel the Bunker Hill & Sullivan mine is as important as ever in its long history. Because of the depth at which it was found it holds promise of operations continuing indefinitely on the same scale we are now going. The continuity of ore at depth is now established."

Cottrell Plant Will Recover Dust in Crushing Plant

One of the interesting features of the new crushing plant that is nearing completion at the United Verde Copper Co.'s smelter, at Clarkdale, Ariz., is the installation for dust removal. This part of the plant is not yet installed, but the equipment is on the ground and the work of erecting it will be commenced soon. The system will differ from that used at most other crushers in that the high-grade ore handled will warrant the installation of a Cottrell precipitation unit at the discharge.



Kings pit, Asbestos Corporation of Canada's principal mine at Thetford



Experimental plant of Selective Treatment, Ltd., at Thetford Mines, with Bennett-Martin mill at the right

solves itself into the question as to how much can be recovered from the ore, not in terms of fibre, but in terms of dollars.

According to Mr. Dolbear, he has been able to demonstrate that his process will recover from two to four times as much measured in dollars per ton as is recovered by dry methods from the same ore. This has been arrived at by comparing actual recoveries in dry plants with recoveries obtained on lots cut from the regular mill run.

The selective-treatment process differs essentially from the method at present in use, in that it employs water as a medium of treatment. The ore is first broken in the usual way to reduce it to 2½- or 3-in. ring. A Marcy ball mill is then used for further treatment; it is contended that by proper regulation of the mill operation the asbestos is freed with a minimum of breakage of the long fibre. The mixture of fibre and rock is delivered to a special type of separator, developed by B. L. Eastman and S. H. Dolbear, to which has been given the name Eastman Separator.

Experiments have shown that various types of apparatus may be employed to effect a separation of loose fibre and rock, although it requires a special apparatus to get a high recovery. It may be stated, however, that the mere separation of loose fibre and rock is a relatively small problem as compared to other phases of the treatment necessary to accomplish the desired result. Other concentrating steps are employed, and the fibre is ultimately dried and put into condition for market. A marketable product is produced by the operation, and the factors employed in the process are adjustable to such an extent that the characteristics of the product may be varied to meet requirements. The company has patent protection in all of the countries where asbestos is produced.

Tintic Standard Mill Makes 90 Per Cent Silver Recovery

The Tintic Standard mill at Warm Creek, Utah, treated 200 tons of siliceous silver ores daily during October, and a silver recovery of above 90 per cent was made. This makes a larger tonnage than ever before treated, and a greater recovery. The ore deposits of the mine at Eureka are opening up steadily with development, and ore resources are being added to. The building of another group of cottages at the mine has begun, and when these are finished there will be in all more than eighty cottages owned by the company. These are modern in all respects. Over 370 men are employed.

Sioux Con. Will Develop Through Colorado Workings

The management of the Sioux Consolidated mine, of Eureka, Utah, has announced a new point of departure in its development plans. Its lower ground will be developed from the Colorado mine, starting at the 1,950 level of that property. Sioux ground will be reached with a little over 250 ft. of drifting. An east-west fissure will be followed into the territory underlying the old Sioux workings, in the past productive of rich ore. The company is planning also to make use of its water system for the benefit of the East Tintic section. About 5,000 ft. of 4-in. pipe is being laid to convey water to the various mines in this neighborhood.

Prospectors Like Rossland Ore at $1,000 "per Sack"

OWNERS of the I. X. L. mine, situated near Rossland, B. C., have another shipment ready for transportation to the Bunker Hill & Sullivan smelter, at Kellogg, Idaho. The last shipment netted the eight lessees of the mine approximately $3,000 apiece. The present shipment is expected to run to $1,000 per sack. The ore has been taken from a narrow, short chimney, which up to the present shows no sign of giving out. The splendid return for the amount of labor expended has given impetus to prospecting at several other points in the Rossland district; several old mines are being reopened, and this, together with the activity at the Consolidated company's mines, has given the old camp a renewed air of prosperity.

Kennedy Finds Vein on 4,200 Level in California

Sixty Stamps Dropping—Number to Be Increased—More Miners Available Than Needed

The Kennedy Mining & Milling Co., operating at Jackson, Calif., has deepened its shaft to the 4,200 level and extended a crosscut to the vein which has been intersected. The footwall vein is 16 ft. in width. Gouge on the footwall, from 16 in. to 4 ft. in width, consists of clay, mixed slates, quartz, and greenstone. The crosscut has penetrated the vein a distance of 41 ft. and is now in the horse which separates the footwall vein from the east vein. Both veins are branches of the same vein. Both the footwall vein and the horse are mineralized, and the assays are consistent with those obtained from the level above. It is expected that the east vein will be intersected in the near future. A drift is being extended north upon the footwall vein. The vein has a slightly steeper dip than on the level above and is wider. The vertical shaft is now 4,316 ft. in depth, or about 134 ft. deeper than the lowest working in the neighboring Argonaut mine. At present sixty stamps are being operated and this number will be increased when the 4,200 level produces. The labor situation is good, as more men are applying for work than can be employed.

Federal M. &. S. Co. Options More British Columbia Prospects

The Federal Mining & Smelting Co. has still further increased its holdings in the vicinity of the Grand Trunk Pacific Ry. by bonding a group of claims 13 miles from Usk from Hugh Forest. The consideration was $30,000, and a substantial cash payment was made. A considerable amount of surface development, including several short adits, has been done, and some promising ore, well mineralized with bornite, has been uncovered. Besides the two large consolidations, the Duthie Mines and the Jefferson group, the Federal has four other groups under option in the neighborhood of the railway.

Mohawk's Yield Full Pound Better Than in 1922

Word from the Michigan copper country says that Mohawk ground at depth in Nos. 6 and 4 shafts is maintaining the splendid copper content. This has been responsible for an increase in yield of refined copper over that of 1922 by fully one pound per ton of rock. The lode in No. 1 shaft is leaner and will remain closed until the price of copper goes higher. Mohawk still is short-handed in its two working shafts, but it is expected this difficulty will be overcome by spring. Wolverine rock continues to run close to 18 lb. per ton, due to improvement in copper content of the ores in old stopes and pillars.

Magma Copper Will Stop Shipments to Hayden, Jan. 1

Own Smelter to Be Ready in March—Development in East End Encouraging

On Jan. 1, 1924, the Magma Copper Co. will begin bedding its ore and concentrate in anticipation of starting the new smelter in March. Production, now around 1,000,000 lb. per month, will be doubled early in the year. Shipments to the Hayden smelter of the A. S. & R. Co. cease on Dec. 31.

Magma soon will be mining at the rate of 625 tons a day, about 80 per cent of the output going to the mill for concentration and the rest in the form of oxidized and high-grade sulphide ore will be sent direct to the new smelter. With the company mining 625 tons of ore a day, output will be at the rate of 24,000,000 lb. of copper a year. At that rate, and after the smelter has reached normal operation, cost of producing copper should be around nine cents a pound, according to estimates in engineers' report of March, 1922.

Prospecting of the property on the east end of the 2,000 level continues to be encouraging and it is probable that a good body of ore will also be opened up at that end of the vein. About 200 ft. easterly from the last diamond drill hole that struck ore, another hole has cut ore. This core showed approximately 4 ft. of direct shipping ore averaging 8 per cent copper adjoining 3 ft. of 1½ per cent ore.

This is the third hole to show good ore. The first hole, which was about 1,055 ft. east of the main crosscut connecting No. 2 and No. 3 shafts, showed 1¾ ft. of 12 per cent copper, 21 oz. of silver and $1.60 gold a ton in the first stringer passed through, and about 100 ft. beyond, 5 ft. averaging 3 per cent copper and 4¾ oz. silver with small values in gold. The second hole showed 5 ft. of ore averaging 13½ per cent copper and 11 oz. silver a ton. Just what the relationship of this drill-hole ore is to that opened up to the east of the shaft on the 1,600 level will not be known until further work has been done.

Snow Storm Would Raise Money to Sink Winze

The Snow Storm Mines Co., operating on the Montana-Idaho state line near Troy, Mont., is preparing plans for financing deeper operation. The board has decided to issue 200,000 shares of treasury stock at 90c. per share, each purchaser to be given a certificate of indebtedness against its earnings with 5 per cent interest. Plans call for the opening of stations at intervals of 250 ft. below the No. 7 level. The winze will be started a half mile from the portal of that level.

Leo Greenough, president, states that the metallurgical problems have been solved and that the proposed plan should develop ore sufficient to keep the 500-ton concentrator in operation and to put the mine on a profitable basis.

The Talache Mines Co., operating on Pend Oreille Lake, in Idaho, has opened a vein on the No. 12 level, 1,200 ft. below the surface. The new vein is reported as 12 in. wide and has been followed for 100 ft. The ore contains 105 oz. silver per ton. Ore from the drift is going to the concentrator, now on a one shift basis treating 50 tons per day. About 100 men are employed in mine and mill.

Ontario Metal Output 18 Per Cent Greater Than Year Ago

For Nine Months Nickel and Silver Up; Gold Down—Power Shortage Responsible

The report of the Ontario Department of Mines just issued, on the output of the metalliferous mines and smelters for the nine months ended Sept. 30, shows a total production valued at $31,803,000, compared with $26,924,000 for the corresponding period of the previous year, or an increase of 18 per cent. The output of gold shows a decrease of $1,000,000 for the nine months, which is attributable to the power shortage in the earlier months of the year. Production for the third quarter was at the rate of 95,566 oz. a month, or approximately $23,000,000 a year, which shows that under normal conditions a substantial increase will be registered. Production of silver amounted to 8,605,000 oz., valued at $5,633,000, an increase of over 1,000,000 oz. in output, but a comparatively small increase in value. The biggest increase was in the nickel-copper production of the Sudbury district. Nickel is figured at 20c. a pound, which is 5c. less than in 1922, but copper is figured at 10c. a pound, or 1c. more than in 1922. The production of metallic-nickel was 8,337 tons, valued at $3,269,000, an increase of $1,250,000. Nickel exported in the form of matte amounted to 6,962 tons, valued at $2,785,000, an increase of $1,200,000. Metallic copper production was 5,000 tons, valued at $1,523,000, an increase of $1,280,000, and copper exported in the form of matte was 4,368 tons, valued at $874,000.

Metallic cobalt, cobalt oxides, and unseparated cobalt-nickel oxides and residues also show increases, the total value of these products being $1,353,000, an increase of approximately $500,000. Among the gold mines in Porcupine the Dome treated the highest grade of ore, with an average recovery of $11.40 a ton. The McIntyre was next, with an average of $10; the Hollinger recovery was $7.40. In Kirkland Lake the Lake Shore showed the highest average recovery, which was $24 a ton. Teck-Hughes recovery was $21.70, Wright-Hargreaves $10.10, and for the small tonnage treated by the Kirkland Lake Proprietary the recovery was $6.65 a ton. The Nipissing was the largest silver producer, with an output of 2,526,000 oz. for the nine months. The Mining Corporation produced 1,702,000 oz., Keeley 1,135,000 oz., O'Brien 662,000 oz., and Coniagas 618,000 oz.

Labor Situation in Michigan Best in Three Years

Germans Arrive in Large Numbers—Seem Contented Though Inexperienced—Get "First Papers"

One hundred and thirty-eight Germans have arrived at Calumet, in the Michigan copper district, where they will be employed by Calumet & Hecla Consolidated. The men came direct from Germany and were admitted to this country by special permit of the Bureau of Immigration. Previously, approximately 150 had arrived at different times, in groups, to work for Calumet & Hecla, and in addition a considerable number have come into the district and found employment at the Copper Range, Quincy, and other mines.

The Germans, it is believed, will make capable miners. They range in age from eighteen to thirty-five years.

The movement of Germans to the Michigan copper country was started by the arrival some months ago of four or five immigrants, relatives of men here before the war. They were impressed with conditions and wages and wrote to relatives and friends in Germany. That the new arrivals are content and intend to remain in this country is attested by the fact that to date 116 of them have applied for their first papers of citizenship, in the Houghton County Circuit Court, forty-two of whom made application at one time. They have no desire to return to Germany, and have expressed themselves as eager to become citizens.

With men coming into the Michigan district and none going out, just the reverse of the situation a year ago, sentiment has undergone a marked change for the better. Buildings long closed and boarded up are being reopened and business generally is beginning to take on new life. A considerable number of men have arrived from points in the United States, principally the northwestern states, and altogether the labor situation is better than it has been at any time in the last three years. More men would be employed, however, if they were available.

Park City M. & S. Increases High-grade Shipments

The Park City Mining & Smelting Co., in Park City, Utah, is increasing the output of its mines. During the week ended Nov. 24 shipments amounted to 1,464 tons, compared with 961 tons the week preceding, and a higher rate is to be maintained. The heavier output will come from shipments of higher-grade ore rather than from concentrates, as the company does not at present intend to work the mill for more than one shift. Much development has been done during the four months just ending, and this has now reached such a point that it will be possible to continue development, and at the same time increase production. The orebody on the 900, opened about a year ago in the old Judge and Daly West ground, continues its heavy production.

Park-Utah Prepares for Increased Shipments

Active Development Since July—New Railway Spur Helps—Power Facilities Increased—Dividends as Usual

THE Park-Utah mine, Park City, Utah, has declared its regular quarterly dividend of 15c. a share or $150,000, payable Jan. 1, bringing the total by the company thus far to $1,147,962. Since the ending of the Pittman Act, especial attention has been given to development work, and emphasis has not been laid on production.

It is announced that from now on the output of the mine will be increased, as practically all of the arrangements for keeping up larger and more economical production have been completed. The branch line of the Union Pacific to the Ontario Drain Tunnel has been practically finished, so that only the work of putting in switches and double-tracking the yards and of ballasting the roadbed with cinders remains to be done. Railroad track facilities have been provided for sixteen gondolas having a loading capacity of fifty-five to sixty-six tons per car. The loading dock has been built, so as to provide for the handling with economy of any tonnage of the various grades of ore produced by the mine. There are no bins at the surface, as the ore can be dumped directly from the mine cars into the railroad cars.

Underground storage facilities for the output of two or three days has been provided. At the townsite arrangements for the comfort and convenience of employees have been completed. A new sewage system has been installed, and an increase in the water supply made. There is a central heating plant connected with all of the buildings in the camp, so that hot-water heat is everywhere available. Another bunk house has been completed, which makes it possible for the company to accommodate 240 men.

A power line has been built from the portal of the Ontario drain tunnel No. 2 to the old Hawkeye shaft, a distance of 9,500 ft. This has been done so that there may be two sources of power, one through the lower workings of the Ontario drain tunnel and the other through the old Hawkeye, so that in case of accident to the one or the other line there may be no interruption of power service. The transformer system has been increased to 300 kva., and additional transformers are on the ground to increase the capacity by another 150 kva.

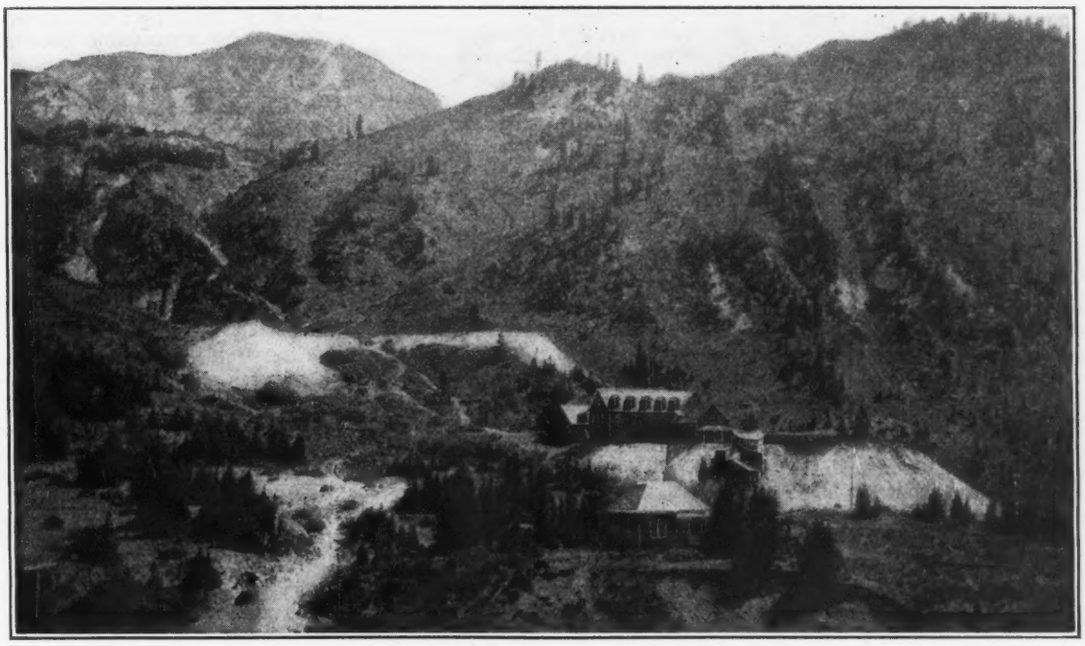
In regard to development work, the vertical shaft, which is being sunk to develop the lower levels, has reached a point halfway between the 1,700 and 1,800 levels; and when the latter level is reached, much prospecting will be undertaken. The inclined winze sunk in the hanging wall of the orebody has reached the 1,700 level, and although the work is still in the hanging wall, high-grade ore is beginning to show. Development work on the 1,500 level is meeting with encouraging results.

Hammon Consolidated Will Increase Equipment at Nome

IT IS reported that the Hammon Consolidated Gold Fields, now operating two new gold dredges in the Nome district, Alaska, will install additional dredges and increase the size of its power plant near Nome. Success has attended the operations of the company. H. R. Edwards and M. L. Summers are in charge of operations at Nome.

North Broken Hill-British Australian Merger Problematical

The British Australian Broken Hill, Ltd., was formed last year to take over the British Broken Hill Proprietary mines in order to obtain local control, primarily with a view to insuring the treatment of concentrates at Port Pirie instead of shipping them to Europe. Recently negotiations have been proceeding for amalgamation with the adjoining North Broken Hill, Ltd. The British mine has ore reserves estimated at 824,000 tons, whereas the North has reserves of 2,500,000 tons above the 1,400 level and diamond drill prospecting at 1,550 ft. goes to show that there is over 1,000,000 tons available on this level. From the point of view of ore reserves therefore it hardly appears that the North Broken Hill Co. needs to acquire the British mine, and a number of shareholders of the latter question the wisdom of the North company paying £140,625 in cash and 100,000 shares.



The South Hecla mine, at Alta, Utah

One of the properties included in the Alta Merger Mines Co., which controls ninety-nine claims in the Alta and American Fork mining districts. The mines have produced $4,000,000 in silver-lead and copper ore. The Alta district has been active for sixty years.

Rich Gold Ore Found in Windpass Mine, North of Kamloops

Development Reveals Good Tonnage—General Leckie Did Not Live to See Success

The recent discovery of high-grade gold ore at the Windpass mine, Chu Chua, about 60 miles north of the City of Kamloops, on the Canadian National Railway, is said by A. W. Davis, the government mining engineer, to be the most noteworthy mining event of the year in the central interior of British Columbia. About two years ago this property was bonded by the late General R. C. Edwards Leckie, with whom were associated Messrs. Trites, Wood, and Wilson, of Fernie, B. C., who met with their first outstanding mining success in the opening up of the Premier mine in the Portland Canal district. General Leckie carried on vigorous development for a year or more. Much stripping and open cut work was done on the outcrops, and a shaft was sunk which ran out of the orebody. A main adit was started from a lower level and carried to the shaft bottom without result. Drifting in various directions, however, was successful. The tragedy of the story is that General Leckie died before it became known that his judgment and faith had been justified.

The death of the prime mover in the enterprise did not alter the determination of his associates to see it through to a definite issue. Now their perseverance has been rewarded. During the last few months not only has a considerable body of high-grade ore been opened, but the outcrops of the vein beyond and the quality of the ore in the bottom level make the chances of the development of further tonnage good.

The Windpass vein lies in a diorite formation. It is not quartzose, the vein filling being chiefly magnetite with a little calcite. Some bismuth telluride is in evidence. The ore probably is primary. A plant is being installed and other preparations are being made for the beginning of shipments.

Will Test Armstead Snow Motor for Transporting Concentrate

The Idaho Continental mine, 26 miles west of Port Hill, Idaho, will place in operation the Armstead snow motor in a few days for the transportation of its ore to the railroad. The great problem confronting the mining company is the hauling of concentrates from the mill to the railroad, a distance of 26 miles over mountain roads from the mine to Port Hill on the railroad. The vicinity of the mine is known as the snow belt in which the snow usually lays 6 to 12 ft. deep in winter. Trucks, caterpillars, and sleighs have all been used, with attendant difficulties. The Idaho Continental mine has large reserves of ore and continuous operation is necessary throughout the year to insure profitable operation.

If the Armstead motor proves successful it will solve a great problem with which isolated mines have been struggling for many years. The conditions at the Idaho Continental are ideal to give the machines a most thorough test.

Quincy, in Michigan, Restores Wage Scale, Recently Cut

THE Quincy Mining Co., in the Michigan copper district, which cut wages 10 per cent on Nov. 1, will restore on Dec. 17 the wage scale previously in effect. Quincy was the only company in the district to reduce wages, an intolerable situation for Quincy from a labor standpoint. The average wage for underground men in the copper mines is now $4.25 per day.

Trail Concentrator Treats 1,000 Tons of Rossland Ore

Formerly Used for Sullivan Ore—High Cost of Coke Important Factor in Displacement of Pyritic Smelting

The Consolidated Mining & Smelting Co. has resumed production at its Rossland mines in British Columbia, which, so far as production is concerned, have been idle since April, 1922, when, owing to the fact that no reduction in the price of coke was in sight, the mines were closed, as the direct semi-pyritic smelting of the ore had ceased to be profitable. The mines are shipping about 1,000 tons of ore per day, and this ore is being treated in the mill at Trail that formerly was used for the concentration of the Sullivan mine ore. The mill has been remodeled to suit the Rossland ores. During the period of non-production the development work in the mines was maintained, and the mines today probably are in a better physical condition than ever before.

The change in the method of treating the ore marks an epoch in the art of metallurgy in British Columbia, the old and once profitable process of semi-pyritic smelting giving place to concentration, followed by the sintering and smelting of the concentrate. Indications point to the same practice ultimately being followed at Anyox, where a 1,500-ton concentrator now is in course of construction. The change has been brought about mainly because of the high price of coke. Despite the fact that it owns its own coal mine, its own byproduct coke ovens, and its own scows to transport the coal from mine to ovens, during the last year coke cost the Granby company approximately 2c. per pound of copper produced. The coal miners of the province, by their demand for a war-time wage when there was deflation in practically every other line of industry, have done their cause incalculable harm; nearly all the principal industries are turning to some other form of fuel, and consequently, coal mining is almost the only mining industry in the province that can truly be said to be languishing.

Candelaria Mines Co. Suspends Operations in Nevada

Could Not Make Ends Meet, Says Kaeding—Operating Profit in May and June—Owes $400,000

The Candelaria Mines Co. closed its mine and mill at Candelaria, Nev., on Nov. 15. The immediate reason for closing was the fact that the ore available was too low grade to pay cost of treatment. The report to stockholders by president Charles D. Kaeding, covering the period March 1 to Oct. 31 of this year, states that total operating costs during recent months have been reduced to $3.20 per ton, and that profits during May and June amounted to over $15,000 per month. The drop in the price of silver, coming as it did about six months before the expected date, was a severe blow to the Candelaria company, and operations have been conducted at a loss for several months.

The Candelaria company owes the Rochester Silver Corporation $400,000, secured by notes and mortgage, which commenced to bear 6 per cent interest last May. Interest payments were never met, and nothing was paid on the principal of the notes, so that it would appear that the Rochester company could foreclose at any time. However, the two boards of directors appear to be in close harmony, and it is probable that plans now being considered, which would obviate the necessity for foreclosure, may be carried out.

A special meeting of the stockholders is to be called in the near future, at which meeting reorganization plans will be discussed, the new stock to be assessable. Funds from assessments will be used to meet obligations and to do some important development work. It has for some time been generally known that the Candelaria Mines Co. was operating on a narrow margin, and that most of the recent ore milled was coming from dumps and fills, resulting in naturally low mining costs; but, even so, the actual condition of the mine and treasury at the present time is disappointing to the stockholders in Nevada.

Gold Hill Mine in Oregon Will Be Reopened

The Gold Hill mine, in the Durkee district of Baker County, Ore., has been purchased, under bond, by J. MacLloyd, L. W. Anderson, W. W. Gifford, and J. P. Acaom, all of Spokane. The mine is equipped with a modern compressor plant and adequate housing for employees. A 1,750-ft. adit has cut five veins on which 2,800 ft. of drifting had been done. Mr. Anderson reports that the average of his mine samples runs $11.88 in gold and silver. Prior operations with a ten-stamp mill lost $5.60 per ton, which it is hoped to save under plans of the new company. The property lies near the O. W. R. & N. Ry. on the old Oregon trail about 10 miles west of the well known and productive Bay Horse property.

Frontier Has Several 10-in. Veins of 5,000-oz. Silver Ore

South Lorrain Mine Develops Well—Nipissing Declares Regular Dividend and Bonus

The Mining Corporation of Canada is meeting with favorable results with the development from its new main shaft on the Frontier property at South Lorrain, in Ontario. Crosscutting from the shaft on the fifth level, which was started only a few weeks ago, has just cut the Watson vein, where it shows an average of 11 in. of 5,000-oz. ore. Although this is a remarkable strike, the company expects the best results will be met with when the fifth and sixth level crosscuts encounter the Woods vein, which should be in about two weeks. The Woods vein has been the best producer in the South Lorrain district, and the Mining Corporation has not yet worked this below the 300 level. A new discovery has also been made on the 230 level on the Woods vein, which shows an average of 10 in. of 5,000-oz. ore.

Shareholders of the Wetlauffer Lorrain Silver Mines are being circularized for their proxies in an effort to obtain a new board of directors, who promise to have the mine unwatered and a report made to see if further work is not justified.

The Nipissing has declared the regular quarterly dividend of 3 per cent, plus a bonus of 3 per cent, payable Jan. 21 to shareholders of record Dec. 31.

The main shaft of the McIntyre mine at Porcupine, Ont., has reached a depth of 2,500 ft., which is the greatest depth obtained in the Porcupine district. Development is now being carried on at the 2,250 and 2,375 levels, with excellent results. Work has been concentrated on the No. 7 vein, which is the most important one in the McIntyre, but four other veins are now being developed at that depth, all of which show ore of good grade. A large tonnage of development rock is going to the mill, but the grade is averaging about $10.50.

C. & A. Assumes Formal Control of Verde Central

Ore on 1,000 Level—"Next Great Producer" According to Local Prophets

The annual meeting of the stockholders of the Verde Central Copper Co. held in Prescott, Ariz., during the past week, marks the formal assumption of control by the Calumet & Arizona Mining Co. Gordon Campbell, president of the latter company, has also been elected president of Verde Central, James E. Fisher, has been elected secretary and treasurer of the subsidiary, and three C. & A. directors were placed on the directorate of Verde Central. W. F. Staunton, general manager of the company has been named as vice-president.

There have been continued reports of successful developments on the 1,000 level of the mine; it has been referred to frequently as "the next great producer of the Jerome district." Development work is being vigorously prosecuted from the small inclined shaft which reaches to the 1,000 level, and it is reported that plans are being perfected for the construction of a large new shaft that will serve for deeper exploration.

Anglo-Canadian Explorers Busy in Northern Ontario

The Anglo-Canadian Explorers has given a contract for a 400-ft. shaft on the Townsite property in Kirkland Lake, Ont. Diamond drilling has given encouraging results, and drill intersections will be developed at a depth of 300 ft. This company has also taken an option on a group of claims in the Gillies Limit, adjoining those which are under option to the Mining Corporation of Canada. It is not expected, however, that the company will do much work for the present, but will wait to see what success the Mining Corporation meets. The latter plans to make a thorough search for ore before the prospect is finally abandoned.

London Letter

By W. A. Doman

Special Correspondent "Engineering and Mining Journal-Press"

London, Nov. 22—Though the country generally views the rise in the "price" of gold with a considerable amount of uneasiness, investors in Rand mining companies regard themselves as fortunate. The higher the price the more paper pounds can be bought with the proceeds of the sale of the metal in New York. It is a sign of the times, too, that many people who have avoided mines hitherto are taking up the shares of the best companies. With such a state of affairs existing on the Continent, and with the uncertainties incident to the general election here, large foreign balances have been withdrawn from London and converted into dollars, thus depreciating sterling beyond the point to which it would naturally fall. Despite the improvement in the dividend prospects of the mines, the managements are still using every endeavor to reduce the costs of production, knowing well enough that the "premium" on gold is not likely to be permanent.

Winning a Profit from Low-grade Ores

As an instance may be mentioned the references in the technical part of the report of the Consolidated Gold Fields of South Africa. This company has always had the misfortune to work mines of low gold content, and consequently has been compelled to concentrate on economies. That it has proved successful no one will deny, for in this matter, as in others, "Necessity is the mother of Invention." Much credit is given in the report to Dr. W. A. Caldecott for the many improvements he has introduced into metallurgical practice, which have ensured high extractions and cheap working. Dr. Caldecott, for many years with the Gold Fields as consulting metallurgist, has recently accepted a responsible position with the Government of the Union of South Africa. The directors of the operating company—the New Consolidated Gold Fields—

The Nipissing mill at Cobalt, Ont.

The Nipissing mine has produced more than 60,000,000 oz. of silver bullion from a refractory ore. The company has just declared a regular dividend of 3 per cent and an extra dividend of the same amount.

have written off some hundreds of thousands of pounds of depreciation from the investments in the last three years, and the book cost of the holdings is now £3,585,727. As Kaffir shares are on the up grade, much of the profit that has been so applied should be recovered during the current year. The total profit to June 30 last was £403,369, against £332,871 in 1921-22, and the Consolidated Gold Fields is enabled to pay a dividend of 6 per cent. As regards the low grade mines, the chief is the Simmer & Jack Proprietary, and it is hoped to carry on profitable operations on 4 dwt. ore. Dividends cannot be large, but to extract any profit from such ore on the Rand is certainly an achievement.

Dredge Tin for 18.11c. Per Yard

During the twelve months ended June 30 last, the Malayan Tin Dredging made satisfactory progress. Five dredges worked and treated 4,206,400 cu.yd. of ground, for a recovery of 1,167 tons of tin ore assaying 74.9 per cent metallic tin. Working expenses at the mine, apart from depreciation, were only 18.11c.—or just over 5d.—per cubic yard. This is one of the best-managed tin-dredging companies.

The directors of the Peña Copper Mines (Huelva, Spain) have reorganized the surface works; all old machinery has been overhauled and a new crushing plant has been constructed. Ore can now be placed f.o.r. at an all-round saving equal to at least one-third of the former cost. The full benefit is not expected to be felt before next year.

Utah Consolidated, Owning Anaconda, Will Be Reorganized

The plan of reorganization of the Utah Consolidated Mining Co. proposes a new corporation with an authorized capital stock of 600,000 shares of $3 par value to be offered at par to stockholders of Utah Consolidated at the rate of two shares for each share now held.

The Utah Consolidated has since Jan. 1, 1922, been indebted to International Smelting Co. (owned by the Anaconda Copper Mining Co.) for $1,300,000 payable on demand and secured by a mortgage upon all the mines, claims and real property of the company. These moneys were obtained to stay execution on the judgment against Utah Consolidated obtained by Utah Apex, since finally affirmed and paid. The suit involved the value of disputed ore.

In addition Utah Consolidated on Oct. 31, 1923, was indebted to the United Metals Selling Co. in the sum of $1,635,-140. This sum with current operating liabilities as of the above date brought total liabilities up to $1,842,162, against which current assets amounted to $1,-463,626, leaving a working capital deficit of $378,536.. This, with the mortgage due the International Smelting Co., makes the total debts of the company stand at $11,654,818.

Washington News

By PAUL WOOTON
Special Correspondent

Budget Provides Increased Funds for Bureau and Survey

Mine Safety, Petroleum, and Experiment Station Appropriations Increased—More for Geological Examinations

The budget submitted at the convening of the new Congress by the President carries $1,909,573 for the Bureau of Mines and $1,805,272 for the Geological Survey. This represents an increase of $139,873 over the amount appropriated for the current fiscal year for the Bureau of Mines and an increase of $135,082 for the Geological Survey.

The amount recommended for the conduct of the work of the Bureau of Mines on investigation as to the causes of mine explosions and as to methods of mining having a relation to safety is $359,768. This is $33,232 less than the amount appropriated for the current fiscal year.

The sum of $262,300 is asked for the investigation and improvement of mine rescue and first-aid methods. This is an increase of $51,300 over the amount appropriated for the current fiscal year. In addition, the budget approves the expenditure of $40,000 for the purchase of an additional mine rescue car.

The budget carries $138,280 for fuel testing. This is $2,280 more than was appropriated last year.

For its mineral mining investigations, other than fuels, the Bureau asks $113,360. The amount appropriated at the last Congress was $125,000.

An increase of $118,305 for the Bureau's petroleum work is carried in the budget. The total appropriation asked for that work is $523,305.

An increase of $25,000 is recommended in connection with the expenses of mining experiment stations. This increase over the current appropriation is asked to enable the expansion of the experimental work being conducted at Salt Lake City. The amount appropriated last year was $175,000. This year's request is for $200,000.

The sum of $91,360, an increase of $11,360, is carried for the Bureau's leasing work. Care of buildings and grounds at Pittsburgh will cost, it is estimated, $57,400, an increase of $2,400. No increase is asked in connection with the Bureau's work in Alaska. The budget carries $35,000 for that purpose. This is the amount of the current appropriation. The budget provides $88,-000 for general administrative expense, an increase of $9,300.

The budget recommends the expenditure of $333,722 by the Geological Survey for its work falling under the technical heading of "geologic surveys." This represents an increase of $33,722.

For topographic surveys the budget allows the Bureau $540,711. This is an increase of $40,711. For chemical and physical researches relating to the geology of the United States, which includes investigations of conditions favorable to the presence of potash deposits, the budget carries $44,000, an increase of $4,000.

The amount recommended for mineral resources reports is $136,734. This is an increase of $12,484. An increase of $3,000 is allowed for the investigation of the mineral resources of Alaska, bringing the total for that purpose to $78,000. Other recommendations in the budget for the Geological Survey are: general administration, $54,760; preparation of illustrations, $21,740; stream gaging and water-supply investigations, $175,000; purchase of books and periodicals, $1,500; for engraving and printing geologic maps, $119,105; for land classification, $300,000.

Webb-Pomerene Act May Be Amended by This Congress

Co-operation Big Advantage in Export Trade—Producers May Organize

Though it is too early to predict what concrete action will be taken by industry, following the discussion at the Department of Commerce about selling combinations, it is known that much interest is being manifested in the general question. Definite steps are expected soon. The time is opportune to secure an amendment to the Webb-Pomerene Act, if it should be found desirable to organize under that statute. This is the law under which the silver producers are considering the formation of an export association.

The agitation at this time of joint sales organizations or selling corporations comprised of non-competing units is being considered in connection with the movement to expand export activities.

Joint sales organizations can be established abroad by non-competing industries without legislation. There are some who believe, however, that advantages would accrue were it possible to organize non-competing activities into Webb Law corporations. It is known that the Webb Act is to be taken up for amendment at this session of Congress.

In the export trade, American manufacturers are having to meet competition from countries where it is entirely legal to combine. The depression in Great Britain is forcing large-scale combinations, which mean reduced overhead charges and the elimination of the less-efficient production units. One of the principal savings is in selling costs. Some middlemen are eliminated and distribution costs are reduced greatly. Knowledge and experience in manufacture can be pooled. Research can be undertaken on a more ambitious scale.

Though American corporations may not take advantage generally of many of these economies, by reason of our anti-trust statutes, some of them can be secured in the handling of exports, and it is believed that Congress is disposed to consider sympathetically various amendments to the Webb-Pomerene Act.

Situation at the Mines

By Arthur B. Parsons
Assistant Editor

DEFINITE IMPROVEMENT in the labor situation featured November. Two reasons, complementing each other, are that workers are coming into the industry and that the number employed is decreasing slightly. As a consequence a surplus has been created, although it is so small that experienced and competent men find no difficulty in getting work. The new men include some immigrants, such as a few hundred Germans who have just arrived in the Michigan copper country; inexperienced men from other domestic industries; and skilled miners who for one reason or another have been engaged at other work but who have returned to the stope, the crosscut, and the drift, at least while the snow flies. The decrease in the number employed is accounted for by scattered shutdowns and curtailments, principally where silver and copper are important metals, and by the suspension of development projects in outlying districts for the winter. Admittedly the general betterment is partly due to seasonal readjustment.

Conditions have been improving gradually for some months, but not until recently has the cry of labor shortage been entirely stilled. Copper companies, of course, sensed the changed situation when they cut wages by about 50c. per day early in November. Incidentally, the Quincy company, which reduced its wage scale on Nov. 1 without getting concerted action on the part of the other companies in the Michigan copper district, has announced that it will restore the former scale, probably finding that the best miners sought work elsewhere. Michigan wages are the lowest in the country; apparently, Calumet & Hecla and the other companies think them low enough in spite of sundry compensating advantages in living conditions. The United Verde Extension, at Jerome, is virtually the only copper producer in Arizona that did not join in the wage cut. It will be interesting to see whether the most desirable workers gravitate toward U. V. X. Managers of most lead, zinc, silver and gold mines, who, thus far at least, have retained the old scales doubtless expect to get the cream of the migrating miner population. However, it is safe to say that with a small surplus of workers and jobs not too easy to get the individual efficiency of the miner will go up. That will help ease the strain on the mine manager.

"High-cost" copper companies are economizing determinedly in an effort to avoid shutting down. They were getting 12⅞c. for their metal on Dec. 1 as against 12⅜c. on Nov. 1, which helped balance sheets materially. Many companies dislike to deplete their ore reserves on the present copper market; on the other hand, to keep per-pound costs down they must approach normal operating capacities. "Normal" is an elusive term, but the situation is described fairly accurately by saying that most companies are producing at their most *effective* capacity under existing conditions.

Lead production probably is at a little higher rate than a month ago in spite of the temporary suspension of the National Lead Co. caused by the burning of its crushing plant in southeastern Missouri. Shipments of lead ore have increased both to Utah smelters and to the Leadville smelter of the A. S. & R. Co. The miner settled at 6$\frac{9}{10}$c. at the close of November, just a little better than at the start.

The zinc market likewise improved a little during the month, helped, no doubt, by the suspension of production in the Joplin-Miami district during the first week of the month. The prevailing quotation of 6⅝c. means a little better than $40 per ton for "jack," which assures reasonable prosperity for the miner even if he must shut down for a week each month.

Another Nevada silver-mining company has succumbed, the Candelaria Mines Co. having suspended operations. The recent report of the Chief Consolidated of Utah, ascribing a reduction in profit from $364,316 in the second quarter to $82,613 in the third to the completion of Pittman Act silver purchases, looks worse than it really is. The mine worked so hard to disgorge every ounce of silver it could while the dollar price lasted that it has had to slow down to recover its breath. Increased profits may no doubt be looked for in the future. The Park-Utah is a typical silver property that has subordinated production to development since July 1, in preparation for larger production under more favorable mine conditions.

The United States S. R. & M. Co. has blown in one copper furnace at its Mammoth smelter, in California; at the same time the Mountain Copper Co. shut down its copper smelter only recently started. The Tonopah Belmont has abandoned the Belmont-Shawmut gold mine, on the Mother Lode.

In Nevada the Consolidated Gold Fields of South Africa has exercised sundry important options on Comstock Lode properties. Development work has been curtailed, pending, it is said, the formation of elaborate operating plans. Tonopah bullion production is $320,000 per month.

Miscellaneous custom ores consigned to Utah smelters have increased. The Murray and Midvale plants are each operating five lead blast furnaces, with an extra matte furnace at Midvale. At Garfield, four large copper reverberatories are running, and at Tooele the International has two lead and one copper furnace in operation. The Ohio Copper Co. shipped three carloads of cement copper from its "leaching-in-place" operations at Bingham on Nov. 30.

The Bunker Hill & Sullivan, in the Coeur d'Alene, Idaho, has found the oreshoot on its bottom level, thereby assuring longer life. Lead output in the district is at the rate of 18,500 tons per month. Active mines in Washington and Oregon and elsewhere in Idaho include the Idaho Continental, Talache, Gladstone, Dominion Silver Lead, Black Rock, and Bay Horse. From the Republic district 2,000 tons of $15 gold ore is mined monthly.

Gold production at Cripple Creek, in Colorado, has increased slightly to $350,000 monthly. The Rawley mine, financed by the Metals Exploration Co. and the A. S. & R. Co., was shut down on Dec. 1 after making 2,500 tons of concentrate in a remodeled mill. Three lead furnaces are in blast at the A. S. & R. smelter at Leadville, where new steel mixing bins are being built.

Joplin-Miami production of zinc concentrate averaged 13,500 tons during three active weeks of November. In southeastern Missouri operations are at the maximum, except for the temporary shutdown of the National Lead Co., caused by the recent fire. It is hoped to be able to resume at full capacity some time in February. Only one of the four furnaces at the St. Joe lead smelter at Herculaneum, Mo., is now in blast, the bulk of the concentrate produced going to the Federal smelter, at Alton, Ill., under the terms of the contract made last month when the Federal sold its mines and mills to the St. Joseph company.

Michigan copper production was 11,360,000 lb. in November, or at about the same rate as in October.

With the exception of 1918, the biggest year, 1923 sets a record for iron ore production in the Lake Superior region, 59,000,000 tons. Many operators look for a lower price for ore in 1924.

Two gold mills have just been put in operation in the Porcupine district in northern Ontario: the Vipond, 150 tons per day; and the Nighthawk Peninsular, 200 tons. The Hollinger is milling and cyaniding 4,700 tons of ore per day. At Cobalt the Colonial and Genessee are new shippers of silver ore.

The Granby copper smelter, at Anyox, B. C., has been idle most of the month as a consequence of a landslide which put the hydro-electric plant out of operation. The Allenby copper property has been shut down tight pending a better market outlook. The Consolidated M. & S. Co. has begun production at its Rossland mines, shipping 1,000 tons per day to Trail for concentration. The new Sullivan concentrator is handling 2,000 tons of ore per day.

THE MARKET REPORT

Daily Prices of Metals

Nov.	Copper, N. Y. net refinery*	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N. Y.	St. L.	St. L.
29	.....	.....	.....	....	....	....
30	12.875	46.75	47.25	6.90	6.75@6.85	6 375
Dec. 1	12.875	46.875	47.375	7.00	6 85	6 35
3	12.875	46.875	47.375	7.00	6.90@7.00	6.35
4	12.875	46.50	47.00	7.00	7.00	6.35
5	12.875	47.00	47 50	7.25@7.375	7.125	6.325
Av.	12 875	46.800	47 300	7 043	6.945	6 350

*These prices correspond to the following quotations for copper delivered: Nov. 30 to Dec. 5, inclusive, 13.125c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

The quotations are arrived at by a committee consisting of the market editors of *Engineering and Mining Journal-Press* and a special representative of the Bureau of Mines and the Bureau of Foreign and Domestic Commerce.

London

Nov.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
29	62¼	63	67½	233	233½	30⅝	29¼	33⅛	33⅜
30	62¼	63	67½	236½	237	31	29	33	33⅛
Dec. 3	62⅜	63⅛	67¾	238⅜	239¼	31½	29¾	33	33¼
4	62¼	63¼	67¾	236¾	237⅝	31½	30	32⅞	33⅛
5	62	62¾	67¾	236¾	237¾	31¼	29¾	32½	32⅞

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Nov.	Sterling Exchange "Checks"	Silver		Gold London	Dec.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
29	.....	...	33¼	94s 8d	3	4.34	64⅜	33⅜	94s 10d
30	4.33¼	64⅜	33 7/16	94s 11d	4	4.33¼	64¼	33¼	95s 1d
Dec. 1	4.33½	64⅛	33¼	.....	5	4.37½	64⅜	33 1/16	94s 8d

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-quarter of a cent premium.

Average Metal Prices for November

Copper:	
New York Electrolytic	12.727
London Standard	61.648
London Electrolytic	66.477
Lead:	
New York	6.846
St. Louis	6.582
London	30.352
Silver:	
New York	63.818
London	32.774
Sterling Exchange	437.839
Zinc:	
St. Louis	6.347
London	32.949
Tin:	
99 per cent	43.495
Straits	43.995
London	220.710
Antimony	9.156
Quicksilver	61.917
Platinum	124.479

Metal Markets

New York, Dec. 5, 1923

Copper

Consumers have been rather anxious to get copper at 13c., delivered, during the last few days, and have been freely intimating that they could get all they wanted at that price. So far as we can learn, however, sales at that level have been confined to only a few carloads, though an appreciable tonnage has been sold at 13c. for delivery in the New York district, where delivery charges are low. A small amount of copper has been sold as high as 13.25c., but 13⅛c. delivered represents the bulk of the sales and is a fair average of all the business booked during the week. The volume of sales has not been large, either here or abroad. Producers generally are holding at from 13⅛ to 13¼c.

Lead

The official contract price of the American Smelting & Refining Co. was advanced from 6.85 to 7c., New York, on Saturday, Dec. 1, and to 7.25c. today, Dec. 5.

Lead is scarcer than at any time since last February, and some producers are not only completely sold out for December and January so far as they are able to estimate production, but are behind in their deliveries. After the advance of the Smelting company last Saturday, quotations of other producers and dealers were advanced, and in the last day or two December lead has been practically unobtainable and January lead has been quoted at from 7⅜ to 7½c. Until today these fancy prices seem to have been entirely nominal, but today a good tonnage of lead was sold to a consumer for January shipment at 7⅜c. The St. Louis market has also registered a rapid advance, with prompt stocks of the metal being held at 7⅛c. today. The advance does not seem to be a temporary one, for the underlying conditions are extremely sound. Consumption in England has improved, and certainly has not declined in this country, the cable and battery business being particularly flourishing.

Zinc

The zinc market has been inactive all week, though inquiries today amounted to a very fair tonnage in all. Smelters are not pressing the metal on the market at present prices for the ore and the metal, so but little decline has been registered despite slack demand. High-grade continues in good demand at 8@8½c., delivered. Forward zinc is slightly stronger than prompt, January commanding about 6.35c. today, whereas spot might be obtained for 6.30c.

Tin

Consumers have not been anxious to buy at the advanced prices, and only small tonnages for near-by requirements have been sold. Forward metal has sold for slightly less than spot in some instances.

Arrivals of tin, in long tons, as compiled by the New York Metal Exchange:

	November, 1923	Eleven Months, 1923
Straits	3,375	45,725
English	475	7,435
Chinese	230	5,249
Banka and Billiton	75	3,858
Australian	25	395
Sundries	..	50
	4,180	62,712

Foreign Exchange

On Tuesday, Dec. 4, cable quotations on francs were 5.40c., and lire, 4.3375c. Canadian dollars, 2 3/32 per cent discount.

Silver

The New York market has been steady for the last week, fluctuations in sterling exchange and the London price practically offsetting each other.

Mexican Dollars—Nov. 30th, 49⅛; Dec. 1st, 48⅞; 3rd, 49⅛ 4th, 48⅞; 5th, 48⅞.

Other Metals

Quotations cover large wholesale lots, f.o.b. New York, unless otherwise specified.

Aluminum—99 per cent, 27c. per lb.; 98 per cent, 26c. London, 98 per cent, £115 per long ton.

Antimony — Chinese and Japanese brands, 8¾@9c. W. C. C., 9⅛@9⅜c. Cookson's "C" grade, spot, 10½c. Chinese needle antimony, lump, nominal, 5.50c. per lb. Standard powdered needle antimony (200 mesh), 6@6.50c. per lb. White antimony oxide, Chinese, guaranteed 99 per cent Sb_2O_3, 7.50c.

Bismuth—$2.55 per lb. London, 10s.

Cadmium—75c. per lb. London, 2s. 6d.

Cobalt—$3 per lb. for spot. Discounts on contracts. Oxide, $2.10@$2.25. London, 12s. for metal; 9s. for black oxide.

Iridium—$275@$300 per oz.

Magnesium—Sticks, 1⅜ in., 99.9 per cent, $1.25 per lb. London quotes 3s. 3d. for 99 per cent.

[1]**Molybdenum**—99 per cent, $12 per lb.

Monel Metal—32c. per lb.

Nickel—27@30c. per lb. for 99 per cent virgin metal. London, £125@£130.

Osmium—$107 per troy oz. in New York.

Palladium—$83 per oz. London, £17. Nominal.

Platinum—$125 per oz. London, £25 for manufactured; sponge, £23. Market strong.

Quicksilver—$60 per 75-lb. flask. San Francisco wires $60.35. London £9¾. Present price below replacement.

Radium—$70 per mg. radium content.

Rhodium—$100@$105 per oz.

Selenium — Black powdered, amorphous, 99.5 per cent pure, $2.10 per lb.

Tantalum—Metal, $380 per kg.

Tellurium—$2 per lb.

[1]**Thallium Metal**—Ingot, 99 per cent pure, $8 per lb.

Tungsten Metal—Powder, 97 to 98 per cent, 95c.@$1 per lb. contained tungsten.

Metallic Ores

Chrome Ore—Indian chrome ore, $19.50 per ton, c.i.f. Atlantic ports. Rhodesian, $21.50 and New Caledonian, $24.

Iron Ore—Lake Superior ores, per long ton, Lower Lake ports: Old Range bessemer, 55 per cent iron, $6.45; Mesabi bessemer. 55 per cent iron, $6.20; Old Range non-bessemer, 51½ per cent iron, $5.70; Mesabi non-bessemer, 51½ per cent iron, $5.55.

Magnetite Ore — F.o.b. Port Henry, **N. Y.: Old bed 21 furnace, $5 per long ton; old bed concentrates, 63 per cent, $5.25; Harmony, cobbed, 63 per cent, $5.25; new bed low phosphorus, 65 per cent, $7.50.**

Manganese Ore—38@42c. per long ton unit, seaport, plus duty; chemical ore, plus 82 per cent MnO_2. $75@$80 per gross ton, powdered. Nominal.

Molybdenum Ore—75c. per lb. of MoS_2 for 85 per cent MoS_2 concentrates. Nominal.

Tantalum—$400 per kilogram.

[1]**Titanium Ores**—Ilmenite, 50 per cent TiO_2, 1½c. per lb. for ore. Rutile, 94 per cent TiO_2, 10c. per lb. for car lots.

Tungsten Ore—High-grade wolframite, $8.50; high-grade scheelite, $9.50@$10 per unit. Ordinary grades, $8@$8.25. Nominal.

[1]**Vanadium Ore**—75c.@$1 per lb. of V_2O_5.

Zircon—$50 per ton.

Zinc and Lead Ore Markets

Joplin, Mo., Dec. 1—Zinc blende, per ton, high, $43.85; basis 60 per cent zinc, premium, $41.50; Prime Western, $40.50 @$41; fines and slimes, $40@$38.50 average settling price, all zinc ores, $42.02.

Lead, high, $87.60; basis 80 per cent lead, open market price, $83; pool market price, $87.50; average settling price all lead ore, $80.75 per ton.

Shipments for the week: Blende, 15,027; lead, 1,243 tons. Value, all ores the week, $732,050.

Holders of lead organized a 1,000-ton pool this week.

Platteville, Wis., Dec. 1—Blende, basis 60 per cent zinc, $44 per ton. Lead, basis 80 per cent lead, $70 per ton. Shipments for the week: Blende, 494 tons; lead, none. Shipments for the year: Blende, 29,319; lead, 720 tons. Shipments for the week to separating plants, 931 tons blende.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can only serve as a general guide as to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can only be ascertained by direct negotiation between buyer and seller.

Asbestos—Crude No. 1, $325@$450; No. 2, $200@$250; spinning fibers, $100 @$125; magnesia and compressed sheet fibers, $60@$90; shingle stock, $50@$70; paper stock, $30@$40; cement stock, $17@$20; floats, $6@$12—all per short ton, f.o.b. mines, Quebec, tax and bags included.

No. 1 Rhodesian crude, $325; No. 2, $200 per short ton, c.i.f., New York.

Barytes—Crude, $7@$10 per ton, f.o.b. mines; $15 per ton, f.o.b. New York. Ground, white, $15@$16; off-color, $13@$14, f.o.b. Baltimore. Water ground and water floated, $26@$28, f.o.b. St. Louis.

Good outlook for 1924. Purchases are on about same basis as in 1923, according to one large dealer.

Bauxite—American, crushed and dried, $5.50@$8.75 per gross ton; pulverized and dried, $12@$14 per gross ton; calcined, crushed, $20@$24 per gross ton, all f.o.b. shipping points.

Foreign red bauxite, French, 5 per cent SiO_2, $5@$6; Dalmatian, 2 per cent SiO_2, $6@$6.50 per metric ton, according to grade; foreign white grades, low iron content, $7.50@$8.50, c.i.f.

Beryl—4½c. per lb. f.o.b. Connecticut points.

Borax—Granulated and refined, crystals or powdered, in bags, carloads, 5½c. per lb.; in bbls., 5½c. Boric acid, 10½c.

Chalk—English, extra light, 5c. Domestic light, 4½@4½c.; heavy, 3½@3½c. per lb., all f.o.b. New York.

China Clay (Kaolin)—Crude No. 1, $7; No. 2, $6; washed, $8@$9; powdered, $13@$20, f.o.b. Virginia points. Imported lump, $15@$20, f.o.b. American ports; powdered, $45@$50, f.o.b. New York. 1A grade, refined, $15@$16 per ton, Delaware.

Diatomaceous Earth—Natural aggregate, $25 per ton; insulating powder, $45; filtration powder, $35; calcined aggregate, $45, f.o.b. plant, California.

Emery—Greek Naxos, 6@7c.; Turkish, 6@6½c.; Khasia, 5@5½c. per lb., f.o.b. factory. American, 4@4½c., f.o.b. shipping points, packed in 350 lb. kegs.

Feldspar—In Maine, No. 1 pottery grade, $19 per ton; market good. Grade 97 per cent pure offered at $10, f.o.b. quarry, water shipment. No. 1 grade in Ontario, $5.50, with good demand.

In Connecticut, No. 1 spar, $7 per ton; No. 2, $6.50. Pulverized, 60 mesh to 80 mesh, $18; 200 mesh, $25 per ton.

In New York, No. 1 crude, $8 per ton.

In North Carolina, No. 1 ground, 140 mesh, $17 per ton. No. 2 ground, 90 to 100 mesh, $10 per ton. No. 1, $7 @$7.50; No. 2, $6@$6.75 per long ton, f.o.b. railroad sidings.

No. 1 Canadian ground, $20 per net ton, f.o.b. mill.

In New Hampshire, ground, $16@$19 per ton. Market good.

Fluorspar—95 per cent CaF_2, 3 per cent SiO_2, $20 per net ton, c.i.f. New York in bond. Nominal.

Washed gravel, 85 per cent and over calcium fluoride, 5 per cent and under silica, $23.50 per ton; 85 per cent CaF_2 and not over 6 per cent silica, $23;

[1]Price furnished by Foote Mineral Co., Philadelphia, Pa.

80 per cent CaF_2 and not over 5 per cent silica, $22.

Ground spar in package for glass and enameling trade, highest grade, $49; lower grade, $39 per ton.

No. 2 lump, 85 per cent CaF_2 and not over 5 per cent silica, $24 per ton.

All above prices except where noted, f.o.b. Middle Western mines. Market quiet.

Fuller's Earth—16 to 60 mesh, $18 per ton; 16 to 30 mesh, $17; 30 to 60 mesh, $18; 60 to 100 mesh, $14.50; 100 mesh and finer, $7.50; f.o.b. Florida mines. Market fair.

Garnet—Spanish grades $60 per short ton, f.o.b. port of entry. Domestic Adirondack grades, $85 per ton f.o.b. shipping points. Canadian, $70@$80, f.o.b. shipping point. Good demand for quality product.

Graphite—Ceylon lump, first quality, 5¾@6¼c. per lb.; chip, 4¾@5¼c.; dust, 3¾@4c. Market quiet.

Mexican amorphous, $15@$35 per ton, New York.

Gypsum—Crushed rock, $3@$4.50 per ton. Ground, $3.50@$8.50, f.o.b. shipping points.

Kaolin—See China Clay.

Limestone—Crushed, New York State shipping points, ½ in. and larger, $1.10 @$1.75 per net ton. Agricultural limestone, pulverized, $2.50@$4.50 per net ton, f.o.b. eastern shipping points.

Magnesite—Crude magnesite, $14 per ton; calcined $35@$37, f.o.b. shipping point in California. Market very good.

Dead-burned magnesite in sacks, $40 @$42, Chester, Pa.; in bulk, $32@$34, Chewelah, Wash.

Caustic calcined, Grecian, $50@$51, c.i.f. New York.

Manjak—Barbados, in 1 to 5 ton lots, grade "A," 9c. per lb.; grade "AA," 11c. per lb.; grade "CM," 13½c.; grade "CF," 12c.; grade "CL," 14½c. Market languid.

Mica—Domestic, No. 1 quality, 1½x2 in., 10c. per lb.; 2x2 in., 35c.; 2x3 in., 70c.; 3x3 in., $1.30; 3x4 in., $1.75; 3x5 in., $2.25; 4x6 in., $3.25; scrap, $18@$20 per ton, North Carolina. Prices nominal.

Scrap, $22 per ton; washer and disk, $8@$15 per ton, f.o.b. N. H. mill.

[1]**Monazite—Minimum 6 per cent ThO_2, 6@8c. per lb.**

Ocher—"Yellow Peruvian," $20@$30 per ton, Georgia mines.

Phosphate — 77 to 76 per cent tricalcium phosphate, hard rock, $7.50 per ton, f.o.b. Jacksonville; 77 to 76 per cent pebble grades, $6.75; 75 to 74 per cent pebble, $5.50; 70 per cent pebble, $4.25; 66 to 68 per cent pebble, $3.75, f.o.b. Tampa.

In Tennessee, 65 per cent ground rock, $5.50@$6.50 per ton; 72 per cent washed, unground, $5.50@$6 per long ton; 75 per cent lump, free of fines, $6.50; 78 per cent, lump, $8@$8.50 per long ton.

Freight to Hamburg, Rotterdam, Bremen, $3; Scandinavia and Baltic ports, $3.50@$3.75 per ton.

Pumice Stone—Imported lump, 3@ 40c. per lb.; domestic lump, 5c.; ground, 5@6c., all f.o.b. New York.

Pyrites—Imported lump, 1 in. diameter and up, 12c. per long ton unit; furnace size, 2½ in. diameter, 12c. per long ton unit; fines, through ½-in. mesh, 12c. per long ton unit; cinder property of buyer, ex ship, Atlantic ports. Ore contains 50@51 per cent sulphur; cinder about 63 per cent iron.

Market limited but improving.

Silica—450 mesh, $31; 350 mesh, $25; 200 mesh, $20; 100 mesh, $8; all f.o.b. Illinois plant, water ground and floated for paints and polishes.

Glass sand, $2@$2.50 per ton; brick sand, $2@$2.25; moulding sand, $2@ $2.25; building sand, $2@$2.25; motor sand, $2@$2.25.

Sulphur—$16@$18 per ton for domestic, f.o.b. Texas and Louisiana mines; $18@$20 for export, f.a.s. New York.

Talc—Ground talc, 150 to 200 mesh, $6.50@$8.50 per ton, bags extra, Vermont.

Roofing grades, $6@$7 per ton; paper grades, $9@$14; Vermont.

Through 20 to 50 mesh, $7@$9 per ton; 100 to 200 mesh, $8@$16; steel workers' crayons, $1.25@$2.25 per gross, Vermont mills.

Gray-white, $8; yellow, $9; red, $12; North Carolina.

Grade A, 350 mesh, $22; grade B, 300 mesh, $18; grade C, $12 per ton, f.o.b. New York. Double air-floated talc, 325 mesh, $14.75 per ton.

Tripoli—Once ground, rose and cream colored, $16@$25; white, $18@$27; double ground, r. and c., $17@$25; w., $19@$30; air-float, r. and c., $25@$30; w., $35; super air-float, r. and c., $35@ $40; w., $40@$45. All per short ton in 200-lb. burlap bags with paper liners, minimum car, 30 tons, f.o.b. Missouri.

Mineral Products

Arsenious Oxide (white arsenic)—13½c. per lb.

Copper Sulphate — 4.75@4.90c. with freight allowed, for domestic material.

Sodium Nitrate—$2.45 per 100 lb., ex vessel Atlantic ports.

Potassium Sulphate—Basis 90 per cent, $43.67 per ton.

Sodium Sulphate—$26@$28 per ton, New York.

Ferro-Alloys

[1]**Ferrocerium—$7 per lb.**

Ferrochrome—1 to 2 per cent carbon, 30c. per lb.; 4 to 6 per cent carbon, 12c. per lb.

Ferromanganese — Domestic, 78@82 per cent, $109 per gross ton, f.o.b. furnace. Spiegeleisen, 19@21 per cent, $40, f.o.b. furnace; 16@19 per cent, $38@$39.

Ferromolybdenum—$2@$2.50 per lb. of contained molybdenum for 50 to 55 per cent grades.

[1]Price furnished by Foote Mineral Co., Philadelphia, Pa.

Ferrosilicon—10 to 12 per cent, $43 @$50 per gross ton, f.o.b. works; 50 per cent $82.50@$85 delivered.

Ferrotitanium—For 15 to 18 per cent material, $200 per ton, f.o.b. Niagara Falls, N. Y.

Ferrotungsten—88@95c. per lb. of contained W, f.o.b. works. Quiet.

[1]**Ferro-uranium**—35 to 40 per cent U, $4.50 per lb. of U contained, f.o.b. works.

Ferrovanadium — $3.50@$4 per lb. of V contained, f.o.b. works. Active.

Metal Products

Rolled Copper—Sheets, 21c.; wire, 15½c.

Lead Sheets—Full lead sheets, 10.25c. per lb.; cut lead sheets, 10.50c. in quantity, mill lots.

Nickel Silver—28c. per lb. for 18 per cent nickel Grade "A" sheets.

Yellow Metal — Dimension sheets, 18.75c. per lb.; rods, 15.75c. per lb.

Zinc Sheets—9.25c. per lb., f.o.b. works.

Refractories

Bauxite Brick—$140@$145 per M. Pittsburgh, Pa.

Chrome Brick—$50@$52 per net ton, f.o.b. shipping point.

Firebrick—First quality, $42@$45 per M., Ohio and Kentucky works; $42@$45 Central Pennsylvania; second quality, $35@$38.

Magnesite Brick — 9-in. straights, $65@$68 per net ton, f.o.b. works.

Magnesite Cement—$47@$50 per net ton, f.o.b. Chester, Pa.

Silica Brick—$42@$45 per M., Pennsylvania; $50@$53 Alabama.

Zirkite—Powdered, 80 per cent ZrO_2, 5c. per lb.; 70 per cent, 2½c. per lb. Brick, straights, 75@95c. each.

The Iron Trade

Pittsburgh, Dec. 3, 1923

The rate of steel production is declining, but at no rapid pace, and the further decreases expected this month will be considered simply seasonal. Heavier operations in January are already predicted.

Tin plate, sheet, and pipe mills are operating at about 85 per cent of full normal, with bar, shape, plate, and wire mills at lower rates. Rail mills are promised practically a full run for the first half of 1924.

Pig Iron—Foundry iron is clearly established at $1 advance, or at $22, Valley, as a result of the recent buying movement. Basic is firm at $21, or $1 advance, in sympathy, and bessemer, formerly weak at $23, seems now to be firm at the figure. Inquiry is fair.

Connellsville Coke—The market is much steadier, with prompt at $4 for furnace and $5@$5.50 for foundry. Operators hope to secure an advance on first quarter furnace coke.

METAL STATISTICS

Monthly Average Prices of Metals

Silver

	New York		London		Sterling Exchange	
	1922	1923	1922	1923	1922	1923
January	65.450	65.668	35.035	31.928	421.750	465.053
February	65.290	64.313	33.891	30.875	435.511	468.631
March	64.440	67.556	33.269	32.310	436.912	469.269
April	66.575	66.855	34.080	32.346	440.715	465.220
May	71.154	67.043	36.023	32.611	444.106	462.252
June	71.149	64.861	35.900	31.611	444.615	461.132
July	70.245	63.015	35.644	30.942	444.165	456.025
August	69.417	62.793	34.957	30.952	446.069	455.714
September	69.515	64.203	35.305	31.698	442.800	453.901
October	68.015	63.649	34.498	31.718	443.583	452.024
November	65.177	63.818	32.882	32.774	447.484	437.839
December	63.905	.....	31.383	.....	460.440	.....
Year	67.528		34.406		442.346	

New York quotations cents per ounce troy, 999 fine, foreign silver. London pence per ounce, sterling silver, 925 fine.

Copper

	New York		London			
	Electrolytic		Standard		Electrolytic	
	1922	1923	1922	1923	1922	1923
January	13.465	14.510	65.226	64.494	72.321	71.409
February	12.864	15.355	60.250	67.700	66.125	74.500
March	12.567	16.832	59.245	73.851	65.739	81.464
April	12.573	16.663	58.799	73.169	64.028	81.331
May	13.111	15.440	61.092	67.460	66.554	76.568
June	13.575	14.663	61.988	66.607	69.333	73.238
July	13.654	14.321	63.137	65.278	70.321	72.364
August	13.723	13.872	63.784	64.034	69.932	70.000
September	13.748	13.323	63.113	63.194	70.917	68.275
October	13.632	12.574	62.773	60.614	70.693	64.250
November	13.598	12.727	62.795	61.648	70.216	66.477
December	14.074	.....	63.267	.....	70.132	.....
Year	13.382		62.123		68.859	

New York quotations, cents per lb. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London	
	1922	1923	1922	1923	1922	1923
January	4.700	7.633	4.388	7.571	23.667	27.119
February	4.700	8.050	4.396	8.093	20.681	28.519
March	4.720	8.252	4.421	8.254	21.266	28.815
April	5.115	8.101	4.946	7.996	22.993	26.956
May	5.420	7.306	5.281	7.085	24.462	25.614
June	5.745	7.146	5.563	6.852	24.685	25.429
July	5.729	6.237	5.447	6.126	24.869	24.188
August	5.824	6.582	5.537	6.496	24.580	24.222
September	6.110	6.856	5.868	6.700	24.131	25.688
October	6.530	6.831	6.338	6.570	25.551	27.815
November	7.047	6.846	6.868	6.582	26.199	30.352
December	7.163	.....	6.978	.....	26.079	.....
Year	5.734		5.503		24.097	

New York and St. Louis quotations, cents per lb. London, pounds sterling per long ton.

Tin

	New York				London	
	99%		Straits			
	1922	1923	1922	1923	1922	1923
January	31.480	37.986	32.100	39.173	163.065	181.852
February	29.835	40.693	30.767	42.011	149.850	190.513
March	28.426	46.569	29.171	48.569	143.152	219.607
April	29.810	44.280	30.605	45.810	149.840	213.081
May	30.149	42.346	30.971	43.135	150.163	203.097
June	30.707	40.375	31.497	40.957	152.512	191.798
July	31.025	37.970	31.733	38.490	156.149	181.188
August	32.134	38.841	32.380	39.269	160.006	186.705
September	32.075	41.047	32.395	41.547	160.005	198.263
October	33.935	41.322	34.600	41.851	170.563	203.957
November	35.911	43.495	36.734	43.995	179.341	220.710
December	36.480	.....	37.695	.....	178.697	.....
Year	31.831		32.554		159.450	

New York quotations, cents per lb. London, pounds sterling per long ton.

Zinc

	St. Louis		London	
	1922	1923	1922	1923
January	4.691	6.815	26.321	35.733
February	4.485	7.152	24.213	35.613
March	4.658	7.706	25.467	36.720
April	4.906	7.197	26.576	34.275
May	5.110	6.625	27.304	31.057
June	5.346	6.031	27.893	29.548
July	5.694	6.089	29.042	29.335
August	6.212	6.325	31.170	32.386
September	6.548	6.438	31.750	33.469
October	6.840	6.293	34.528	32.995
November	7.104	6.347	38.011	32.949
December	6.999	.....	37.757	.....
Year	5.716		30.003	

St. Louis quotations, cents per pound. London, pounds sterling, per long ton.

Antimony, Quicksilver and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1922	1923	1922	1923	1922	1923
January	4.463	6.884	49.960	72.731	97.260	112.462
February	4.416	7.290	48.295	70.636	89.545	113.273
March	4.319	8.885	50.204	70.808	87.500	110.846
April	4.980	8.380	52.280	69.200	87.500	116.840
May	5.467	7.477	54.885	68.000	85.529	115.007
June	5.145	6.839	55.115	67.769	87.212	115.615
July	5.091	7.097	55.000	66.980	90.180	116.000
August	5.315	7.753	57.593	65.212	98.370	116.000
September	6.580	7.633	67.640	63.000	117.280	116.000
October	6.905	8.005	72.560	61.769	109.440	116.923
November	6.584	9.156	71.521	61.917	108.000	124.479
December	6.382	.....	72.300	.....	113.600	.....
Year	5.471	.....	58.946	.....	97.618	.....

(a) Antimony quotations in cents per lb. for ordinary brands. (b) Quicksilver in dollars per flask. (c) Platinum in dollars per ounce.

Pig Iron, Pittsburgh

	Bessemer		Basic		No. 2 Foundry	
	1922	1923	1922	1923	1922	1923
January	21.55	29.27	20.15	27.35	21.34	28.77
February	21.46	29.79	19.71	28.15	20.88	27.21
March	21.35	32.03	19.96	31.79	20.83	31.77
April	22.50	32.77	21.26	32.77	22.70	32.77
May	26.36	31.87	26.87	29.83	25.96	32.46
June	26.96	30.27	26.96	28.34	25.96	29.81
July	26.77	28.47	26.33	26.52	25.97	27.47
August	30.44	28.27	27.18	26.77	30.81	26.77
September	35.27	28.26	34.70	26.26	36.79	26.72
October	35.27	26.96	31.77	25.01	33.40	25.52
November	33.52	24.79	29.37	22.57	30.55	23.60
December	29.87	.....	26.34	.....	27.69	.....
Year	27.61	.....	25.88	.....	26.91	.....

In dollars per long ton.

Monthly Crude Copper Production

	1923			
	July	August	September	October
Alaska shipments	7,160,887	6,353,425	8,507,154	8,819,469
Washoe smelter	17,100,000	17,100,000	16,100,000	19,000,000
Calumet & Arizona	3,492,000	3,046,000	3,386,000	3,226,000
Calumet & Hecla	(c)	(c)	(c)	(c)
Other Lake Superior	(c)	(c)	(c)	(c)
Chino	5,716,379	4,202,636	3,838,675	(c)
East Butte	(c)	(c)	(c)	(c)
Inspiration	(c)	(c)	(c)	(c)
Miami	5,164,000	5,144,000	4,676,000	5,590,000
Nevada Consolidated	5,254,796	5,881,420	5,999,167	(c)
New Cornelia	3,183,192	3,372,243	3,271,655	3,436,861
Old Dominion	2,220,000	2,015,000	2,040,000	2,314,000
Phelps Dodge	8,478,000	9,745,000	9,857,000	13,608,000
Ray	4,832,180	5,447,123	5,724,249	(c)
Shattuck Arizona	(c)	(c)	(c)	(c)
Southwest Metals Co.	1,215,000	1,072,283	960,415	800,000
United Verde	(c)	(c)	(c)	(c)
United Verde Extension	3,579,748	3,553,046	3,209,216	3,320,514
Utah Copper	19,529,362	20,521,352	19,033,832	(c)
Others, estimated	12,000,000	18,000,000	18,500,000	16,900,000
Total United States	.....	.....	.....	.....
Imports: Ore and concentrates, matte	9,022,193	15,750,000	14,738.801	.....
Imports of black and blister, unrefined	35,213,686	30,379,000	36,810,274	.....
Imports of refined and old	9,131,647	2,999,000	10,493,214	.....
Grand total	.....	.....	.....	.....
Backus & Johnston	(c)	(c)	(c)	(c)
Boleo	1,409,64	1,422,148	1,237,005	1,248,030
Cananea	(c)	(c)	(c)	(c)
Cerro de Pasco	(c)	(c)	(c)	(c)
Chile	(c)	(c)	(c)	(c)
Cons. M. & S. of Canada	(a)	(a)	(a)	(a)
Falcon Mines	448,000	502,740	(c)	500,600
Furukawa	798,000	2,585,285	3,001,603	(c)
Granby Cons.	2,485,651	3,436,369	2,876,592	2,606,372
Katanga	12,612,600	12,266,415	12,072,375	11,428,513
Mount Morgan	784,000	858,000	(c)	(c)
Mount Lyell	798,000	1,012,000	(c)	(c)
Phelps Dodge Mexican	2,726,000	1,829,000	3,417,000	3,331,000
Sumitomo	2,372,289	2,372,289	2,230,707	(c)
Wallaroo & Moonta	816,523	748.702	827,787	(c)

Comparative Monthly Copper Production

	1920	1921	1922	1923
January	121,903,744	90,596,597	32,010,292	(b) 112,341,000
February	117,540,000	86,682,941	45,957,530	(b) 102,641,000
March	120,309,316	91,046,345	55,705,760	(b) 122,202,000
April	116,078,871	46,946,523	(b) 76,601,000	(b) 117,914,000
May	114,964,207	25,310,511	(b) 88,714,000	(b) 124,785,000
June	116,107,856	24,623,693	(b) 93,740,000	.....
July	109,729,610	22,033,739	(b) 91,000,000	.....
August	112,460,254	23,248,398	(b) 101,188,000	.....
September	104,919,562	23,855,316	(b) 96,408,000	.....
October	105,231,571	23,231,572	(b) 103,273,000	.....
November	106,700,178	28,341,442	(b) 102,845,000	.....
December	95,709,009	26,629,137	(b) 103,003,000	.....

(a) No copper produced during this month. (b) Department of Commerce. (c) Not available.

Company Reports

Teck-Hughes Gold Mines, Ltd.

Gold; Kirkland Lake, Ontario

A report of the operations of the Teck-Hughes Gold Mines, Ltd., for the fiscal year ended Aug. 31, 1923, shows a profit earned by the company since March 2, 1923, as $303,457.63, according to the following operating account:

Revenue

Bullion production	$981,525.07	
Exchange premium on mint settlements	12,519.05	
Interest earned	4,334.69	
		$998,378.81

Expenditure

Development and exploration	$124,117.65	
Mining	102,387.83	
Milling	99,388.17	
General expense	74,215.92	
Depreciation on fixed plant	12,607.60	
Extraordinary expense	4,413.55	
Financial charges	21,178.73	
		438,309.45
Net operating profit for year		$560,069.36
Reserve for federal taxes	$30,000.00	
Less surplus on 1922 Reserve	210.10	
		29,790.00
Net surplus for year		$530,279.36
Deduct profit for period from Sept. 1, 1922, to March 1, 1923, absorbed in adjustments attendant upon amalgamation with Orr Gold Mines, Ltd.		226,821.73
Profit-and-loss account balance, as per balance sheet, being profit earned by new company from date of incorporation March 2, 1923, to Aug. 31, 1923		$303,457.63

Balance sheet as of Aug. 31, 1923, is given as follows:

Assets

Cash on hand and in banks		$233,041.48
Bullion on hand		47,924.67
Inventory of general stores		47,317.44
Accounts receivable		45.69
Prepaid insurance		1,007.42
Equipment, tools and furniture		44,687.13
Buildings and fixed plant	$178,607.86	
Less depreciation reserve	37,822.80	
		140,785.06
Mining properties		4,535,273.33
		$5,050,082.22

Liabilities

Accounts and wages payable	$35,551.77
Bonds payable and accrued interest	175,928.82
Reserve for federal taxes	30,000.00
Capital stock	4,505,144.00
Profit-and-loss account, balance at credit	303,457.63
	$5,050,082.22

Production amounted to 34,690 tons of ore, yielding $981,525 or $28.30 per ton.

Early in January of this year negotiations for the acquisition of the Orr Gold Mines, Ltd., property were renewed, and in February were satisfactorily completed, and The Teck-Hughes Gold Mines, Ltd., was organized, taking over the property of Teck-Hughes Gold Mines, Ltd., and the property of Orr Gold Mines, Ltd.

The directors consider that their policy of extensive development has been fully warranted by the results, and that the size of the development will probably require the location and sinking of a new shaft capable of handling a larger tonnage, and the erection of a new mill of larger capacity. Conditions of operation with the present mill and the unusual richness of the ore make it economically necessary to keep the amount treated per day down to one hundred tons. The management wishes to be extremely conservative in finally determining the location of the new shaft and the size of the new mill, and will probably at later date definitely recommend in detail the carrying out of such policy.

Under "Development and Exploration" there has been expended $3.58 per ton, which has been charged against the total cost per ton of operation.

It is expected the remaining outstanding bonds will be retired on the next interest date—Jan. 1, 1924.

Imports and Exports of Ores and Metals

Imports and exports of ores and metals during October, 1923, with revised comparative figures for October, 1922:

Imports

In Pounds Unless Otherwise Stated

	October, 1922	October, 1923
Antimony		
Ore	.....	253,046
Metal, matte, and regulus	694,176	1,478,848
Copper		
Ore	1,097,650	12,559,227
Concentrates	6,423,810	2,146,926
Regulus, coarse metal and cement copper	76,293	32,648
Total	7,597,753	14,738,801
Imported from		
Spain	192,388	.....
Canada	.....	2,411,109
Mexico	4,757,555	2,245,319
Cuba	1,964,212	.....
Chile	475,183	8,441,900
Colombia	35	25,909
Peru	18,666	61,676
Venezuela	.....	1,450,756
Other countries	189,714	102,132
Unrefined black, blister and converter copper in pigs and bars	20,981,031	36,810,274
Imported from		
United Kingdom	92,996	.....
Canada	3,230,807	4,995,699
Mexico	6,782,514	7,808,376
Chile	4,292,246	14,221,061
Peru	6,582,468	9,785,013
Other countries	.....	125
Refined copper	12,322,785	10,208,701
Old and clippings for remanufacture	776,637	277,849
Composition metal, copper chief value	223,162	4,061
Copper manufactures	27,794	2,603
Brass		
Old and clippings for remanufacture	9,387,714	958,329
Manufactures of brass	69,461	73,101
Lead		
Ore and matte	1,328,595	11,174,809
Bullion or base bullion	4,825,143	16,833,302
Pigs, bars, other forms and old	356,023	1,438
Manufactures of lead (except type metal)	19,775	27,777
Manganese ore, long tons	18,452	16,842
Pyrites, long tons	14,671	.....
Tin		
Tin ore	1,006	842
Tin in bars, blocks and pigs	14,939,193	13,052,834
Imported from:		
United Kingdom	1,652,373	2,611,615
British Straits Settlements	9,694,791	9,447,191
China	.....	111,710
Dutch East Indies	784,005	570,850
Hongkong	2,532,124	134,732
Australia	152,320	33,600
Other countries	123,580	143,136
Tungsten ore, long tons	21,840	.....
Zinc ore (dutiable)	.....	609,521
Zinc in blocks and pigs (dutiable)	4,533	1,109
Zinc dust (dutiable)	13,398	12,775

Exports

In Pounds

	October, 1922	October, 1923
Copper		
Ores, concentrates matte and regulus (copper content)	22,764	111,919
Copper and manufactures of (total)	55,281,806	76,204,167
Refined, in ingots, bars, etc.	45,193,264	68,040,377
Exported to		
Belgium	2,429,231	4,043,184
France	10,359,187	15,004,864
Germany	9,381,056	3,309,985
Italy	7,378,378	9,609,468
Netherlands	2,587,647	2,314,329
Spain	527,587	78,310
Sweden	4,149,860	5,387,687
United Kingdom	6,612,120	18,660,718
Canada	866,508	3,040,696
China	60	2,766,293
Japan	.....	2,441,262
Other countries	901,630	1,383,581
Old and scrap	331,600	132,646
Composition metal, copper chief value	840	5,377
Pipes and tubes	271,486	379,531
Plates and sheets	493,041	669,068
Wire except insulated	739,810	1,047,848
Lead		
Pigs and bars		
From domestic ore	954,065	85,640
From foreign ore	4,622,774	9,715,639
Exported to		
France	3,585,391	1,288,568
Germany	.....	1,949,781
Netherlands	336,121	551,324
United Kingdom	672,249	4,088,565
Other Europe	224,073	1,288,395
Argentina	.....	112,063
Brazil	701,133	246,488
Other countries	57,872	276,095
Zinc		
Dross	714,937	5,816,990
Spelter:		
From domestic ore	1,267,153	7,395,962
From foreign ore	.....	1,904,706
Total zinc slabs and blocks	1,267,153	9,300,668
Exported to:		
Belgium	673,114	112,029
France	560,074	280,102
United Kingdom	.....	7,586,326
Canada	8,399	64,550
Other countries	25,566	1,257,661
In sheets, strips, etc.	398,949	497,720
Zinc dust	310,701	580,293
Other zinc manufactures	36,459	30,927

MINING STOCKS

Week Ended December 1, 1923

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Ahmeek	Boston	...	...	58	June 23, Q	$1.50
Alaska-Br. Col.	N. Y. Curb	*80	*65	*70	...	...
Allouez	Boston	...	...	*16	Mar. '19	1.00
Anaconda	New York	38⅞	37⅜	37⅞	De. 15, Ja. 21, Q	0.75
Arcadian Consol.	Boston	2½	2	2	...	...
Ariz. Com'l	Boston	8⅛	8	8	July '23,	0.50
Calaveras	N. Y. Curb	...	...	2⅛	...	...
Calumet & Arizona	Boston	44	42½	43⅜	De. 7, De. 24, Q	0.50
Cal. & Hecla (New)	Boston	21	19½	20	De. 1, De. 17	0.50
Centennial	Boston	...	...	7	Dec. '18, SA	1.00
Cerro de Pasco	New York	43½	42¼	43½	Oc. 18, No. 1, Q	1.00
Chile Copper	New York	27⅜	27	27½	De. 1, De. 29, Q	0.62½
Chino	New York	17⅛	16½	16½	Sept. '20, Q	0.37½
Con. Cop. Min. (New)	N. Y. Curb	1½	1½	1⅛	...	...
Copper Range	Boston	26	24½	25	May '23, Q	1.00
Crystal Copper	Boston Curb	67	65	66	...	...
Davis-Daly	Boston	3¼	3⅛	3⅛	Mar. '20, Q	0.25
East Butte	Boston	5⅜	5⅛	5⅛	Dec. '19, A	0.50
First National	Boston Curb	28	28	28	Feb. '19, SA	0.15
Franklin	Boston	1¼	*99	1⅛	...	...
Gadsden Copper	Boston Curb	*43	*37	*43	...	...
Granby Consol.	New York	15	14⅜	14⅜	May '19, Q	1.25
Greene-Cananea	New York	...	...	15⅛	Nov. '20, Q	0.50
Hancock	Boston	1⅜	1⅛	1⅛	...	...
Howe Sound	N. Y. Curb	2⅜	2⅛	2⅛	Oc. 1, Oc 15	0.05
Inspiration Consol.	New York	27	25⅛	25⅛	De. 20, Ja. 7, Q	0.50
Iron Cap	Boston Curb	...	...	4	May 23, K	0.15
Isle Royale	Boston	20⅛	20⅛	20⅛	Se. 1, Se. 15,	0.50
Kennecott	New York	35⅜	34⅛	35⅛	De. 7, Ja. 2, Q	0.75
Keweenaw	Boston	*75	*75	*75	...	...
Lake Copper	Boston	1 1/16	1⅛	1⅛	...	...
Magma Copper	New York	30¼	29	29¼	Jan. '19, Q	0.50
Mason Valley	N. Y. Curb	...	...	1⅞	...	...
Mass Consolidated	Boston	1	1	1	Nov. '17, Q	1.00
Miami Copper	New York	21⅞	21⅛	21⅛	No. 1, No. 15, Q	0.50
Michigan	Boston	1⅛	1⅛	1⅛	...	...
Mohawk	Boston	*34½	*33	*33½	Se. 22, Oc. 13,	1.00
Mother Lode Con.	New York	9⅛	8⅞	9	De. 14, De. 31	0.50
Nevada Consol.	New York	12	11⅛	11⅞	Sept. '20, Q	0.25
New Cornelia	Boston	*16	*15½	*16	Au. 3, Au, 20, Q	0.25
New Dominion	N. Y. Curb	2⅛	2⅛	2⅛	...	...
North Butte	Boston	3	2⅛	2⅛	Oct. '18, Q	0.25
Ohio Copper	N. Y. Curb	*87	*83	*86	...	...
Old Dominion	Boston	17⅜	17	17	Dec. '18, Q	1.00
Osceola	Boston	...	...	31½	June '23, Q	1.00
Phelps Dodge	Open Mar.	†145	†130	...	Se. 20, Oc. 2 Q	1.00
Quincy	Boston	24	22½	22½	Mar. '20, Q	1.00
Ray Consolidated	New York	12⅜	11⅜	12⅛	Dec. '20, Q	0.25
Ray Hercules	N. Y. Curb	*35	*25	*33	...	...
St. Mary's Min. Ld.	Boston	*34	*33	*34	No. 9, De. 11, K	1.00
Seneca Copper	New York	6	5½	5⅜	...	...
Shannon	Boston	*45	*40	*40	Nov. '17, Q	0.25
Shattuck Arizona	New York	6⅛	6	6⅛	Jan. '20, Q	0.25
South Lake	Boston	...	...	½	...	...
Superior & Boston	Boston	1½	1⅜	1⅛	...	...
Tenn. C. & C. cfs.	New York	9⅛	8⅞	8⅞	Se. 29, Oc. 15, Q	0.25
Tuolumne	Boston	*55	*40	*40	May '13,	0.10
United Verde Ex.	N. Y. Curb	27	25½	25½	Oc. 5, No. 1, Q	1.00
Utah Consol.	Boston	*35	*2	*3	Sept '18,	0.25
Utah Copper	New York	64⅜	63⅛	64⅛	Se. 14, Se. 29, Q	1.00
Utah Metal & T.	Boston	*40	*30	*35	Dec. '17,	0.30
Victoria	Boston	...	...	1⅜	...	...
Winona	Boston	*35	*12	*12	...	...
Wolverine	Boston	5⅜	5⅛	5⅜	...	...
NICKEL-COPPER						
Internat. Nickel	New York	12⅛	11⅛	11⅛	Mar.' 19,	0.50
Internat. Nickel pfd.	New York	80¼	80	80	Oc. 11, No. 1 Q.	1.50
LEAD						
Carnegie Lead & Zinc	Pittsburgh	3	2⅛	2⅛	...	...
National Lead	New York	127½	123¼	123¼	De. 14, De. 31, Q	2.00
National Lead pfd.	New York	...	...	112	Au. 24, Se. 15 Q	1.75
St. Joseph Lead	New York	22	20⅛	21⅞	Se. 9, Se. 20 Q, X	0.50
ZINC						
Am. Z. L. & S.	New York	...	...	8⅛	May '20,	1.00
Am. Z. L. & S. pfd.	New York	30	30	30	Nov. '20, Q	1.50
Butte C. & Z.	New York	5⅜	5⅛	5⅜	Mar. '23,	0.50
Butte & Superior	New York	16⅜	15⅜	15⅜	Je. 15, Je. 30, Q	0.50
Callahan Zn-Ld	New York	5¼	4⅞	4⅞	Dec. '20, Q	0.50
New Jersey Zn.	N. Y. Curb	151⅜	151⅜	151⅜	Oc. 31, No. 10, Q	2.00
United Zinc	N. Y. Curb	...	...	*50	...	...
Yellow Pine	Los Angeles	*70	*70	*70	June '23, Q	0.03
SILVER						
Alvarado	N. Y. Curb	1⅜	1⅛	1⅛	...	...
Batopilas Mining	New York	...	...	⅛	Dec. '07, I	0.12½
Beaver Consol.	Toronto	*26½	*24½	*25½	May '20, K	0.03
Candelaria	N. Y. Curb	*4	*2	*2	...	...
Castle-Trethewey	Toronto	*42	*39¾	*41¼	...	...
Coniagas	Toronto	2.20	2.15	2.20	Oc. 19, No. 1, '23	0.02½
Crown Reserve	Toronto	*69½	*68	*69½	Jan. 17,	0.05
Kerr Lake	N. Y. Curb	2⅛	2	2⅛	Oc. 1, Oc. 15, Q	0.12½
La Rose	Toronto	...	...	*24	Apr. '22,	0.10
McKinley-Dar.-Sav.	Toronto	*16	*14½	*14½	Oct. '20, Q	0.03
Mining Corp. Can.	Toronto	3.10	3.02	3.05	Sept. '20, Q	0.12½
Nipissing	N. Y. Curb	6⅛	5⅛	6⅛	Ja. 1, Ja. 21, QX	0.30
Ontario Silver	New York	...	...	6⅛	Jan. '19, Q	0.50
Temiskaming	Toronto	*35	*32	*34	Jan. '20, K	0.04

Stock	Exch.	High	Low	Last		Last Div.
GOLD						
Alaska Gold	New York	⅛	⅛	⅛	...	...
Alaska Juneau	New York	1	⅞	⅞	...	...
Boundary Red M.	N. Y. Curb	...	...	*12	...	...
Carson Hill	Boston	3⅛	2⅛	2⅛	...	...
Cresson Consol. G.	N. Y. Curb	3⅛	3⅛	3⅛	Se. 30, Oc. 10, Q	0.10
Dome Mines	New York	19⅛	18⅛	19⅛	De. 31, Ja. 2, Q	0.50
Golden Cycle	Colo. Springs	1.09	1.09	1.09	Dec. '22, Q	0.02
Hollinger Consol.	Toronto	11.55	11.45	11.48	No. 15, De. 3,	0.05
Homestake Mining	New York	60½	60	60	No. 20, No. 26 M	0.50
Kirkland Lake	Toronto	*32	*31½	*31½	...	...
Lake Shore	Toronto	3.54	3.45	3.48	No. 1, No. 15'23	Q 0.02
McIntyre- Porcupine	New York	17⅛	16½	17⅛	De. 1, Ja. 2,	0.25
Portland	Colo. Springs	...	...	*30	Oct. '20, Q	0.01
Teck-Hughes	N. Y. Curb	1 1/16	1⅛	1 1/16	...	...
Tom Reed	Los Angeles	*61⅛	*59	*57½	Dec. '19,	0.02
United Eastern	N. Y. Curb	1⅛	*98	1 1/16	Oc. 8, Oc. 28, Q	0.15
Vipond Cons.	Toronto	*94	*93	*93	...	...
Wright-Hargreaves	Toronto	3.15	3.05	3.15	Se. 15, Oc. 1, Q	0.02½
Yukon Gold	N. Y. Curb	*75	*51	*75	June '18,	0.02½
GOLD AND SILVER						
Boston-Mont. Corp.	N. Y. Curb	*22	*15	*15	...	...
Con. Cortez	N. Y. Curb	*52	*50	*52	...	...
Con. Virginia	San Francisco	...	...	8½	...	...
Continental Mines	N. Y. Curb	4	4	4	...	...
Dolores Esperanza	N. Y. Curb	*85	*85	*85	Jy. 1, Jy. 10 Q	0.05
Jib Consol	N. Y. Curb	...	...	*65	...	...
Tonopah Belmont	N. Y. Curb	...	...	*38	Apr. '23, Q	0.05
Tonopah Divide	N. Y. Curb	*47	*42	*42	Se. 22, Oc. 10	0.10
Tonopah Extension	N. Y. Curb	1⅛	1⅛	1⅛	De. 11, Ja. 1	0.05
Tonopah Mining	N. Y. Curb	1⅛	1 1/16	1 1/16	Se. 30, Oc. 1	0.07½
Unity Gold	N. Y. Curb	2¼	2¼	2¼	...	...
West End Consol.	N. Y. Curb	*68	*63	*63	Mar. '23, Q	0.05
SILVER-LEAD						
Ahumada	Boston Curb	5⅛	5⅛	5⅛	...	...
Bingham Mines	Boston	17	17	17	Sept. 19, Q	0.25
Cardiff M. & M.	Salt Lake	91	91	91	Dec. '20,	0.15
Chief Consol.	Boston Curb	3⅛	3⅛	3⅛	Oc. 10, No. 1, Q	0.10
Columbus Rexall	Salt Lake	*26	*25	*25	Aug. '22,	0.03
Consol. M. & S.	Montreal	27½	26½	27½	Oct. '20, Q	0.62½
Erupcion	Boston Curb	1⅛	1⅛	1⅛	Se. 15, Oc. 2	0.125
Federal M. & S.	New York	...	...	11⅛	Jan., '09,	1.50
Federal M. & S. pfd.	New York	42	42	42	No. 26, De. 15,	1.75
Florence Silver	Spokane	*13	*12	*13	Apr. '19, Q. X	0.01
Hecla Mining	N. Y. Curb	8⅛	8⅛	8⅛	Au. 15, Se. 15	0.15½
Iron Blossom Con.	N. Y. Curb	...	...	*32	Oct. 25, '23,	0.02
Marsh Mines	N. Y. Curb	*10	*10	*10	June '21, I	0.02½
Park City	Salt Lake	4.00	4.00	4.00	Se. 15, Oc. 1 Q	0.12
Park Utah	N. Y. Curb	...	...	3	Ja. 1, Q	0.15
Prince Consol.	Salt Lake	...	...	*75	Nov. '17,	0.02
Silversmith	Spokane	*33	*30	*30	Oc. 1, Oc. 10	0.01
Simon Silver-Lead	N. Y. Curb	*3	*2	*2	...	...
Snowstorm Silver-L.	N. Y. Curb	...	...	*46	...	...
Tamarack-Custer	Spokane	1.40	1.37	1.38	Se. 30, Oc. 1, K	0.02
Tintic Standard	Salt Lake	3.95	3.65	3.75	Se. 24, Se. 29	0.15
Utah-Apex	Boston	2⅜	2⅜	2⅜	June '23, Q, X	0.50
IRON						
Bethlehem Steel	New York	55⅛	52	53⅜	De. 1, Ja. 2, Q	1.25
Char. Iron	Detroit	⅜	⅜	⅜	...	...
Char. Iron pfd	Detroit	1½	1⅜	1⅜	...	...
Colorado Fuel & Iron	New York	25½	23	23	No. 10, No. 26 Q	2.00
Col. Fuel & Iron pfd.	New York	102	102	102	Feb. '23, Q	2.00
Gt. North'n Iron Ore	New York	33⅜	32	32½	Apr. '23	1.00
Inland Steel	N. Y. Curb	...	...	46	No. 15, De. 1Q	0.62½
Mesabi Iron	N. Y. Curb	...	...	5	...	...
Replogle Steel	New York	14	12	13⅜	...	...
Republic I. & S.	New York	50⅞	48⅛	49⅜	May '21	1.50
Republic I. S. pfd.	New York	93	92⅞	93	De. 15, Ja. 2 Q	1.75
Sloss-Sheffield S. & I.	New York	55	52⅛	53⅜	Feb.' 21,	1.50
Sloss-Shef. S. & I. pfd.	New York	80⅜	80⅛	80⅜	De. 20, Ja. 2, Q	1.75
U. S. Steel	New York	96⅛	94⅛	95⅜	No. 29, De. 29, Q	1.50
U. S. Steel pfd.	New York	119	118⅜	118⅜	No. 4, No. 28, Q	1.75
Virginia I. C. & C.	New York	52	52	52	De. 15, Ja. 2	1.50
Virginia I.C. & C. pfd.	New York	83	83	83	De. 15, Ja. 22	2.50
VANADIUM						
Vanadium Corp.	New York	32⅞	30⅛	30⅜	Jan. '21, Q	1.00
ASBESTOS						
Asbestos Corp.	Montreal	35	35	35	Se. 29, Oc. 15 Q	1.00
Asbestos Corp. pfd.	Montreal	...	...	60	Se. 29, Oc. 15 Q	1.50
SULPHUR						
Freeport Texas	New York	14⅛	12	13⅞	Nov. '19, Q	1.00
Texas Gulf	New York	61⅞	59⅛	59⅛	De. 1, De. 15 QX	2.00
PLATINUM						
So. Am. Gold & P.	N. Y. Curb	3¼	3⅛	3⅛	...	...
MINING, SMELTING AND REFINING						
Amer. Metal	New York	44⅞	44⅛	44⅛	No. 17, De. 1, Q	0.75
Amer. Metal pfd.	New York	...	...	110	No. 19, De 1, Q	1.75
Amer. Sm. & Ref.	New York	...	...	52	Oc. 11, No. 1, Q	1.25
Amer. Sm. & Ref. pfd	New York	95⅞	95⅛	95⅞	No. 9, De. 1,	1.75
U. S. Sm. R. & M.	New York	22⅛	22	22	Jan. '21, Q	0 50
U.S. Sm.R.& M. pfd.	New York	40⅜	40⅛	40⅛	Oc. 8, Oc. 15, Q	0.87½

*Cents per share. †Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. K, Irregular. I, Initial. X, Includes extra.

Toronto quotations courtesy Arthur E. Moysey; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange; Los Angeles, Chamber of Mines and Oil; Colorado Springs, Colorado Springs Stock Exchange.

Current Prices of Mine Materials and Supplies

RISE AND FALL OF THE MARKET

Declines—Steel sheets and track bolts lower at Pittsburgh mill. Spikes also down in San Francisco. Steel structurals declined 10c. per 100 lb. in Chicago. Cast-iron pipe tending downward in New York and San Francisco. Bolts, nuts, washers, etc., reduced in New York and Chicago. Hollow tile down in Philadelphia. General decline in lumber and cement. Linseed oil market weaker as to price. Reduction in rawhide lacings since last month. Zinc dust down ½c. per lb., f.o.b. Palmerton, Pa., since Nov. 10.

Advances—Manila rope, ¾-in., 25c., against 18½c. per lb. last month. Sodium cyanide, 21@22c., compared with 20½c. per lb., one month ago.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh, Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$3.00	$4.45	$4.00	$5.00	$4.59
Black					
No. 28	3.75@3.85	5.20	4.85	5.80	5.15
Galvanized					
No. 28	4.85@5.00	6.35	5.85	6.50	6.15

STEEL RAILS—The following quotations are per ton f.o.b. Pittsburgh and Chicago for carload or larger lots:

	Pittsburgh Current	Pittsburgh One Year Ago	Birmingham	Chicago
Standard bessemer rails	$43.00	$43.00	.....	$43.00
Standard openhearth rails	43.00	43.00	$43.00	43.00

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh Current	Pittsburgh One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅜-in. and larger	$3.15	$2.75	$3.00	$4.00	$4.85	$3.72
Track bolts	4.00	3.85@4.50	4.00	5.05	6.20	4.57
Standard section angle bars	2.75	2.75	2.75	4.00	4.00	3.20

STRUCTURAL MATERIAL—Following are base prices f.o.b. mill, Pittsburgh and Birmingham together with quotations per 100 lb. from warehouses at places named:

	Pittsburgh, Mill	Birmingham Mill	New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$2.50	$3.00	$3.64	$4.20	$3.45	$3.30	$3.60
Channel, 3 to 15 in.	2.50	3.00	3.64	4.20	3.45	3.30	3.60
Angles, 3 to 6 in., ¼ in. thick	2.50	3.00	3.64	4.20	3.45	3.30	3.60
Tees, 3 in. and larger	2.50	3.00	3.64	4.20	3.45	3.30	3.60
Plates	2.50	3.00	3.64	4.30	3.45	3.30	3.60

WIRE ROPE—Discounts from list price, f.o.b. New York and east of Missouri River, on regular grades of bright and galvanized are as follows:

Hercules red strand, all constructions	20%
Cast steel round strand rope	20%
Galvanized steel rigging and guy rope	7½%
Round strand iron and iron tiller	5%
Plow steel round strand rope	35%
Special steel round strand rope	30%

	New York	Cleveland	Chicago
Drill Rod (from list)	55%	40@55%	50%

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

	Inches	Steel Black	Galv.	Inches	Iron Black	Galv.
BUTT WELD—	⅛ to 3	62	50½	⅛ to 1¼	30	13
LAP WELD—	2½ to 6	59	47½	2½ to 4	29	15

STEEL PIPE—From warehouses at the places named the following discounts hold for steel pipe:

	Black New York	Black Chicago	Black St. Louis
2½ to 6 in. lap welded	44%	47%	46%

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	New York Current	New York One Year Ago	Birmingham	Chicago	St. Louis	San Francisco
6 in. and over	$62.10@63.60	$54.30	$49.00	$57.20@60.20	$57.60	$59.00

Nuts—	New York	Cleveland	Chicago
Hot pressed, sq., per 100 lb. Off list	$1.00	$3.50	$3.50
Cold punched, sq., per 100 lb. Off list	1.00	3.50	3.50

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York Current on Trucks	New York One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory
4x12x12	$0.1179	$0.1230	$0.0724	$0.125	$0.089	$0.108	.....
6x12x12	.1769	.1844	.0996	.....	.122	.156	.....
8x12x12	.2211	.2305	.1358	.215	.162	.244	$0.1968

MACHINE BOLTS—	New York	Cleveland	Chicago
½ and 1½x3 in. up to 12 in.	15 %	50—5%	50%

LUMBER—Prices of rough Douglas Fir No. 1 common, in carload lots to dealers in yards at San Francisco. To contractors, $2 per M. ft. additional.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$40.00	$41.00	$42.00	$45.00
3x6 and 8	40.00	41.00	42.00	45.00
4x4-6 and 8	40.00	41.00	42.00	45.00

Wholesale prices to dealers of long leaf yellow pine. To contractors in New York City, delivered from lighters or cars to job, $5 additional.

	New York 20 Ft. and Under	New York 22-24 Ft.	Chicago 20 Ft. and Under	Chicago 22-24 Ft.
3x4 to 8x8	$42.00	$43.00	$42.50	$44.50
3x10 to 10x10	47.00	48.00	48.50	50.50
3x12 to 12x12	52.00	53.00	55.50	57.50

Other Cities	8 x8-In. x 20 Ft. and Under Pine	Fir	Hemlock	Spruce	12 x 12-In. 20 Ft. and Under Pine	Fir
Boston	$65.00	$100.00	$60.00	$58.00	$83.00	$125.00
Cincinnati	40.00	75.00	75.00	90.00	44.00	80.00
Denver	.....	40.75	40.75	40.75	.....	41.75
Minneapolis	42.00	44.75	41.50	.....	44.00	45.75
Kansas City	43.25	.....	.....	.....	53.25	.....
Birmingham	30@35	.....	.....	.....	40@45	.....

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh, Mill	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$3.00	$3.80	$4.25	$4.55	$3.34	$4.95
Cut	....	4.45	5.25	5.75	3.64	5.00

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots *without bags*. Cash discount not deducted.

	Current	One Month Ago	One Year Ago
NewYork, del. by truck	$2.55@2.65	$2.70@2.80	$2.60
Chicago, f.o.b.	2.10	2.20	2.20
Cleveland, f.o.b.	2.41	2.46	2.46

LIME—Warehouse prices:

	Hydrated, per Ton Finishing	Hydrated, per Ton Common	Lump, per Barrel Finishing	Lump, per Barrel 280-lb. net Common
New York	$18.20	$13.10	$3.75	$3.00@$3.25
San Francisco	22.00	.....	.....	(180-lb net) 2.10

LINSEED OIL—These prices are per gallon:

	New York Current	New York One Year Ago	Chicago Current	Chicago One Year Ago
Raw in barrel (5 bbl. lots)	$0.95	$0.90	$0.94	$0.95

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry Current	Dry 1 Yr. Ago	In Oil Current	In Oil 1 Yr. Ago
Red	14.00	13.25	15.50	14.75
White	14.00	13.25	14.00	13.25

HOSE—

Fire: Underwriters' 2½-in. coupled ..... 50-Ft. Lengths 51½c per ft.

Air—Best Grade: ¾-in., per ft. ..... 3 ply $0.33 4 ply $0.42

Steam—Discounts from List: First grade ..... 40–5% Second grade ..... 45% Third grade 50%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition ..... 60–5% Best grade 50–10–5%

LEATHER BELTING—List price, 2c. per sq. in. per ply.

Grade	Discount from list
Medium	30–10%
Heavy	20–5–2½%

RAWHIDE LACING—For cut, best grade, 45–5%, 2nd grade, 55%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 45–5%; sides, 41c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam, ½ in.	$0.90
Rubber sheet	.45
Rubber sheet. wire insertion	.70

MANILA ROPE—Per lb., ¾-in. and larger, 1,200-ft. coils.

Atlanta	$0.25	New Orleans	$0.17½
New York	.17	Seattle	.18
Chicago	.18	San Francisco	.16

EXPLOSIVES—Prices per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.27	$0.295
Minneapolis	.1917	.2123
Denver	.2025	.2275
Seattle	.165	.19
Cincinnati	.225	.25
New Orleans	.195	.22
San Francisco	.1625	.1925

FLOTATION OILS—All prices are per gal. in carload lots; 50-gal. bbls., gross weight 500 lbs.

Pine oil, steam dist., f.o.b. New York	$0.65
Pine oil, pure, dest. dist. f.o.b. New York	.60
Pine tar oil, ref. f.o.b. New York	.48
Pine tar oil, crude, tank cars f.o.b. Jacksonville, Fla	.32

CHEMICALS—

Zinc dust, 550 lb. casks, f.o.b. Palmerton, Pa., per lb	$0.08½
Litharge, delivered New York, casks, 500 lb. lots, per 100 lb	10.40
Sodium cyanide, 220 lb. single case lots, f.o.b. New York, per lb	.21@.22

NEW MACHINERY AND INVENTIONS

New Portable Loader Has Crawler Tread

Ability to cut a path 20 ft. wide through a pile of material is claimed for the new crawler tread, power-swiveling, industrial loader recently put on the market by the Link-Belt Co. of Philadelphia. This new machine is known as the "Grizzly." It is the large capacity, heavy-duty loader of the Link-Belt group—a sort of "parent" to the "Cub" portable belt conveyor, which is extensively used in small yards for loading material of various kinds into trucks.

The new feature of the "Grizzly" loader is the crawler tread. This type of tread has proved successful, and its application to the industrial loader is a distinct improvement, because of the frequent necessity for moving such loaders over railroad tracks, rough and broken ground, piles of loose material, and up inclines.

Another feature is that the lower base is of solid, cast-steel construction. This feature eliminates the numerous rivet and bolt connections and makes for greater durability and rigidity. The lower base, which carries the loading mechanism, pivots on the tread in similar fashion to that employed by the larger and more expensive locomotive cranes.

Tread shoes are of alloy heat-treated steel, cast in one piece, and are attached by a patented design which has proved exceptionally capable of self-cleaning. In the past, it is said, the one fault with mechanisms of this type was their liability to clog with dirt, sand and mud. The Link-Belt self-cleaning tread, as originally applied to the Link-Belt crawler crane, has been adapted to the Grizzly, which, it is claimed, makes such clogging impossible.

One of the principal features of this loader is its ability to swivel and swing independently of the wheel or tread base. It can back into a pile, dig, swivel, and elevate at the same time—or it can do any of these operations independently—all at the will of the operator.

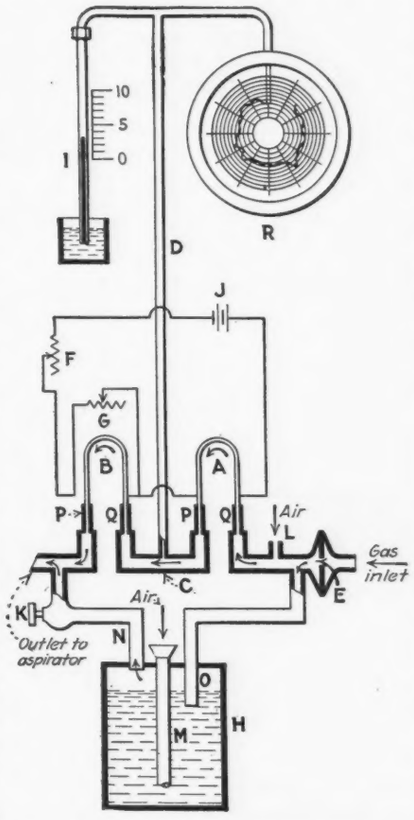
The steering mechanism of the crawler tread is controlled by a hand wheel, all other operations being controlled by levers which are conveniently located on the operator's platform on the upper swiveling frame so that they can readily be reached.

The capacity of any loader will vary with the material handled. For the Grizzly, however, a capacity of 45 cu.ft. per minute is claimed in handling bituminous coal. About the same rate of speed is given for sand and about 40 cu.ft. per minute with 1½ in. and under crushed stone. It is driven by a motor of ample power and of standard design.

Novel Recorder Will Indicate CO Content

Of the various types of instruments placed on the market in recent months for recording the percentage of CO present in a gas, one of the most interesting is that manufactured by the Uehling Instrument Co., Paterson, N. J. This instrument is made as a separate instrument or as an adjunct to the CO_2 recorder.

The accompanying cut illustrates the separate type. *A* and *B* are platinum tubes of small bore, heated electrically, through which the gas being tested flows continuously. The gas enters through the inlet opening *E* and thence



Apparatus for recording CO or other combustible content of gases

through the platinum tube *A*. If CO or any other combustible gas is present, it will burn within the heated tube *A* and increase the tube's temperature more or less, depending upon the amount of combustible present. Then the burnt out gas will flow through the platinum tube *B* and out of the latter under a fixed suction. The hotter the tube *A* becomes the more expanded will be the gas flowing through it and consequently less gas will enter chamber *C* as tube *A* becomes hotter. The outlet suction does not vary, hence a decreasing flow of gas through tube *A* results in a greater partial vacuum in chamber *C*. Thus the varying suction in chamber *C* becomes a measure of the heat units in the gas and by connecting chamber *C* with a recording gage *R*, by means of tubing *D*, the quantity of combustible can be recorded any distance away—for example, in the engineer's office. The recorder is calibrated in percentage of CO; however, if hydrocarbons or hydrogen are present, they will also be recorded in terms of CO or equivalent heat value. It is also feasible to calibrate the instrument in B.t.u. per cubic foot of gas.

The auxiliary indicator *I* is provided also, to be placed on the apparatus where the gas originates, as the furnace or boiler. It serves there as a guide for the operator so that he may get the best results from his work. *L* is a gap through which sufficient air is admitted to insure complete combustion at all times.

Either direct or alternating current may be employed, the current consumption being about 40 watts. The diagram shows the machine operating on a storage battery *J*, with a rheostat *F* in series. Even severe voltage variations have no effect on the accuracy of the instrument because both tubes are heated or cooled to the same degree by such changes and it is only a difference of temperature between the two that affects the suction in chamber *C*. Rheostat *G*, in shunt with platinum tube *B*, provides a means for raising or lowering the temperature of tube *B* a few degrees, which is a simple way of making any slight adjustment required in the initial setting.

When used independently of the Uehling CO_2 recorder, it is necessary to employ a suction regulator *H*. Tube *M*, which is open to the air, extends into the water almost to the bottom of the vessel. Exactly 6 in. above its lower end is the bottom of pipe *O*. Part of the gas entering the instrument is bypassed through pipe *O*, bubbling up through the water in *H* and escaping through pipe *N*. This pipe communicates with an aspirator or main suction through needle valve *K*. The rate of flow depends upon the setting of *K*, which does not have to be exact, so long as it is open sufficiently to cause air to bubble from the end of pipe *M* and gas to bubble from the end of pipe *O*. Under these conditions, pipe *M* is completely filled with air, the water level at its submerged end being consequently at atmospheric pressure. Correspondingly the bottom of pipe *O*, which is 6 in. above the bottom of pipe *M*, is under a constant suction of 6 in. of water head. This suction is thus maintained constant all the way back to the first platinum tube *A*, regardless of any change in the tension of the gas on the inlet side of the opening *E*, caused by draft variations or otherwise.

Make-up water may be added weekly through tube *M*, the exact level of the water being immaterial so long as tube *O* is submerged. An arrangement similar to that used with standard Uehling CO_2 recorders is employed for creating the primary fixed suction at *S*. A steam, air or water aspirator, as preferred, can be supplied. The instrument will indicate as little as 0.1 per cent of CO or equivalent.

INDUSTRIAL NOTES

Largest Hydro-electric Plant in West Running

The first unit of the largest hydro-electric generating station in the West, the Big Creek No. 3 plant of the Southern California Edison Co., which will serve many mining companies, has been placed in operation. This is the fourth power house on the company's Big Creek and San Joaquin project, which when completed will include about ten generating stations, with a combined capacity of over 1,000,000 hp. The power from Big Creek No. 3 is being spread over the entire system of the company, which serves about 300 cities, towns, and rural communities, including Los Angeles.

The Big Creek No. 3 power house consists of two main structures: a concrete building which houses the turbines, generators, and control switchboard; and a 220 kv. outdoor switch rack, which covers an area of 80,000 sq.ft.

The installation described consists of three 35,000 hp. vertical turbines, built by the Wellman-Seaver-Morgan Co. and three Westinghouse 28,000 kva. generators. The turbines operate at a speed of 428 r.p.m. under an effective head of 740 ft. Each turbine is equipped with Woodward governors which are controlled from the switchboard. The generators have exciters directly connected to the top. Power is generated at 11,000 volts and is stepped up to 220 kv., through seven 18,500 kva. Westinghouse transformers.

Newest Coal Pier Operated Electrically

Iron-ore operators in the Lake Superior region will probably be interested in the description of the new electrically operated coal pier of the Western Maryland Ry. Co. at Port Covington, Baltimore, which is given by R. W. McNeill, of the Westinghouse Electric & Manufacturing Co. in the *Electric Journal* for September. The equipment of the new pier consists of a stationary car dumper of the lift and turnover type, with mechanical trimming apparatus for loading boats directly from the dumper pan, and an auxiliary conveying system and trimming apparatus to permit the loading of boats on the side of the pier opposite that on which the dumper pan is located.

All of the pier equipment mentioned is electrically driven by direct-current motors, power being supplied at 230 volts from a 1,500-kw. rotary converter substation located on the pier. This station contains two 750-kw. rotary converters, together with the necessary switching equipment and transformers.

Lyons Fair Next March

The Lyons Fair, an important yearly exposition in Europe, will hold its next meeting in Lyons, France, March 3 to 17, 1924.

American manufacturers, especially those who specialize in labor-saving devices and machinery, have been invited to participate. M. Edouard Herriot, Mayor of Lyons, recently toured this country in behalf of the fair and insisted on the urgent need of such machinery in practically every European country.

Manufacturers who cannot spare the time and expense of attending the meeting personally have been invited to join the all-American demonstration and trade exhibit now being organized by Emile Garden, official delegate of the Lyons Fair for the United States. Display of films and distribution of catalogs and samples will be done in their behalf by Emile Garden during the fair. For full information apply at once to Emile Garden, 50 Church St., New York

Dwight P. Robinson & Co. Open Atlanta Office

Dwight P. Robinson & Co., Inc., of New York, have opened an Atlanta Office in the Healey Building, with W. Rawson Collier in charge. This gives the company a total of eight branches, the others being at Chicago, Pittsburgh, Youngstown, Philadelphia, Montreal, Los Angeles, and Rio de Janeiro.

Among the company's recent activities in the South are the construction of the new wet-process cement plant of the Lehigh Portland Cement Co. at Birmingham, Ala.; extensions to the steel plant of the American Rolling Mill Co. at Ashland, Ky.; extensions to the power generation and distribution systems of the New Orleans Public Service, Inc., New Orleans, and the design and construction of the fifth sulphur mining plant which they have built for the Freeport Sulphur Co. at Hoskins Mound, Texas.

A.S.M.E. Issues New Codes

Copies of two codes—the "Test Code for Hydraulic Power Plants and Their Equipment" and "Rules for the Construction of Low-Pressure Heating Boilers"—are now ready for distribution by the American Society of Mechanical Engineers. The price is 80c. a copy (to members 70c.) and in quantities of twenty-five or more 65c.

The "Test Code for Hydraulic Power Plants" is the first of a series of sixteen test codes to be issued during the coming year by the power test code committee as a result of its years of work on the revision of the test codes of 1915.

The revised Heating Boiler Section constitutes Section IV of the 1923 edition of the Boiler Code. The Steel Plate Section of this code embraces an important innovation in the form of special rules for the construction of low-pressure boilers with welded joints.

Schubert-Christy Company Formed

Frank H. Schubert, district manager of the Wheeler Condenser & Engineering Co., and William G. Christy, secretary, St. Louis Section, American Society of Mechanical Engineers, formerly with St. Louis Boat & Engineering Co., announce the organization of the Schubert-Christy Construction & Machinery Co., with offices in the Railway Exchange Building, St. Louis, Mo. In addition to representing leading manufacturers of power plant equipment, the new firm will render general construction engineering service and specialize in the design and construction of water cooling equipment for refrigerating and power plants, design of special machinery, process development and difficult construction work of various kinds.

Western Electric Makes New Appointments

Important changes in its organization have been announced by the Western Electric Co. These involve the appointment of three new assistant works managers and two superintendents in the manufacturing department. These changes are part of a program of expansion being carried out in the new Western Electric Works at Kearny, N. J., which in their ultimate development may duplicate the company's large plant at Chicago.

C. L. Rice, formerly production superintendent of the Hawthorne Works at Chicago, and S. S. Holmes, general superintendent of installation, have been promoted to be assistant works managers at Hawthorne.

R. C. Dodd, at present operating superintendent of the Hawthorne Works at Chicago, has been promoted to be assistant works manager at the new Kearny, N. J. works. This appointment will become effective on March 1 next.

J. J. McKenna, formerly assistant general purchasing agent at Hawthorne, succeeds Mr. Rice as superintendent of production, and W. H. Meese, supervisor of installation methods and results, succeeds Mr. Dodd as operating superintendent at Hawthorne.

Comment from Dings

Criticising a recent statement in the *Journal-Press* regarding a high duty magnetic pulley which was said to have an attractive force of 100 lb. per square inch, the Dings Magnetic Separator Co., of Milwaukee, says that it is anything but correct. "First of all," says the correspondent, "pounds pull per square inch means absolutely nothing, and secondly, if by the widest stretch of imagination one can picture what the statement means and then choose the most advantageous point on the face of the pulley, the actual figures obtained would approximate one-half of the figure given."